Watershed Planning in Ontario

Guidance for land-use planning authorities

DRAFT February 2018

Ontario

Table of Contents

Please note that this guidance is a draft for engagement purposes. The Province continues to work with municipalities, other interested parties, and First Nations and Metis communities and organizations in developing this document. Any examples are for illustrative purposes of the concepts proposed for watershed planning.

1 How to Read this Document

Watershed Planning Guidance is intended to support municipalities in watershed planning throughout Ontario, to support the implementation of the four provincial land use plans – the Growth Plan for the Greater Golden Horseshoe, 2017 (Growth Plan), the Greenbelt Plan, 2017 (Greenbelt Plan), the Oak Ridges Moraine Conservation Plan, 2017 (ORMCP), and the Niagara Escarpment Plan, 2017 (NEP) and the Provincial Policy Statement, 2014 (PPS). The PPS provides policy direction for communities across Ontario, while provincial land use plans provide policy direction for specific areas.

The Watershed Planning Guidance document is divided into seven main sections, plus additional resources, as outlined in the following paragraphs.

Section 2 Introduction

This section should be consulted for background information and context for watershed and subwatershed planning.

Requirements for watershed planning and subwatershed plans in Ontario's existing legislative and strategic contexts are identified in section 2.1, taking into account province-wide and geographically-specific policies (i.e. PPS and the provincial plan areas). The remainder of section 2 addresses principles, history, current framework, definitions, policy requirements, roles and equivalency provisions.

Section 3 Engagement and Indigenous Perspectives

This section should be consulted to gain an understanding of potential engagement approaches, considerations and Indigenous perspectives.

This section provides best practices and resources for engagement in section 3.1, including public and stakeholder engagement, steering committees, and partnerships.

Guidance is provided for Indigenous engagement in municipal watershed planning in section 3.2, including determining interests and considerations, and traditional knowledge.

Section 4 Watershed Delineation & Characterization

This section should be consulted to determine best practices, approaches, and resources for watershed characterization.

This section provides resources to support watershed characterization, which is a fundamental component of watershed and subwatershed planning. Connections are provided to various watershed planning elements section 6, such as water quality, climate change, and natural systems.

Delineation of watersheds and subwatersheds for municipal planning is outlined in section 4.1.

Identification of water resource systems, as defined in the PPS, Growth Plan, and Greenbelt Plan, is outlined in section 4.2.

Characterization of existing conditions is outlined in section 4.3.

Section 5 Setting the Vision, Objectives, Goals, & Targets

This section should be consulted to determine approaches for visioning and setting objectives, goals, and targets in watershed and subwatershed planning.

This section provides resources to support setting watershed-specific visions, objectives, goals, and targets. Connections with monitoring and adaptive management are provided, to ensure that objectives, goals, and targets for management actions and ecological state can be effectively monitored and adapted.

Section 6 Watershed Planning Elements & Best Practices

This section should be consulted for guidance in undertaking elements of watershed planning.

This section provides resources to support the following components:

- Water budget and water conservation plans are outlined in section 6.1
- Water quality and nutrient load assessments are outlined in section 6.2
- Natural hazards, as they relate to municipal watershed planning, are outlined in section 6.3
- Climate change and extreme weather event considerations, which have been incorporated throughout the document, are outlined in section 6.4.
- Natural systems, and interconnections with water systems and watershed planning, are outlined in section 6.5.
- Cumulative impact assessment approaches are outlined in section 6.6.
- Land use and management scenario analysis methods and best practices are outlined in section 6.7.

Section 7 Developing the Plan & Implementing Provincial Policy

This section should be consulted for guidance to support implementation of watershed planning to inform land use and infrastructure planning.

Development of watershed plans and subwatershed plans, and connections to implementation considerations, are outlined in section 7.1.

Water, wastewater, and stormwater planning considerations are outlined in section 7.2.

Integration of watershed planning with land use planning and development decision-making is also outlined in this section.

Considerations and best practices for implementing watershed planning beyond municipal land use planning are outlined in section 7.3.

Section 8 Monitoring & Adaptive Management

This section should be consulted for guidance in developing environmental monitoring plans and adaptive management strategies.

This section provides guidance regarding environmental monitoring plans; data and communication; adaptive management; watershed plan review and updates; and planning, design, and development approaches to adaptively manage land and water resources.

Section 9 Resources Considered

This section should be consulted for bibliographic references, additional information, and external resources and links related to watershed planning.

This section lists the resources that were considered in the development of the watershed planning guidance, and directs users to additional resources relevant to implementation of watershed planning.

Abbreviated Terms

Appendix A

Summary of requirements by policy area.

2 Introduction

Watershed Planning Guidance is intended for use by municipalities and other planning authorities, in fulfilling provincial land use planning requirements related to watershed and subwatershed planning. The Watershed Planning Guidance will be of interest to those undertaking watershed planning and developing subwatershed plans, as well as those involved in the development and review of policy documents, and the review and approval of development applications.

2.1 WATERSHED PLANNING PROCESS

Watershed planning is an ongoing process involving the development, implementation and regular updating of a watershed plan, and should generally involve the following steps:

Phase 1 Existing Conditions

- Watershed Delineation & Characterization (Section 4)
- Setting the Vision, Objectives, Goals, & Targets (Section 5)

Phase 2 Impacts, Scenarios, and Directions

- Watershed Planning Elements & Best Practices (Section 6)

Phase 3 Watershed Plan Implementation

- Developing the Plan & Implementing Provincial Policy (Section 7)
- Monitoring and Adaptive Management (Section 8)

At the end of Phase 1, an 'existing conditions report' can be produced as a deliverable. During Phase 2, management alternatives can be presented to the public for feedback. In Phase 3, a watershed plan document can be produced as the key deliverable.

More phases can be added to the three listed above in order to respond to local concerns and needs. In some situations, because of resource limitations, an initial phase could be simply the gathering of background data, and establishment and preparation of terms of reference.

Phase 1 will:

- outline the location, extent, sensitivity and significance of all components of the natural systems;
- examine current land uses and extent of pervious/impervious cover;
- identify land/water features, linkages, and processes;

- identify factors and influences that are important to the integrity of various existing or desired components of the environment;
- identify watershed and subwatershed goals, objectives, and targets;
- identify opportunities for protection, enhancement, rehabilitation, and development;
- identify monitoring needs; and
- identify plan review and update schedules.

The complexity of Phase 1 work depends on whether watershed plans or other relevant environmental planning studies have been completed. For example, watershed and subwatershed objectives and targets may already be established and information on natural features to be protected may already exist in environmental or greenspace planning studies. Phase 1 of a watershed or subwatershed plan should incorporate or complement not duplicate previous relevant work. If no previous studies are available, some aspects of the watershed plan could be done as part of Phase 1 activities.

Phase 2 will:

Involve undertaking watershed planning elements specific to requirements outlined in the Growth Plan, Greenbelt Plan, ORMCP, and NEP, including but not limited to:

- water quantity, water budget, and water conservation plans;
- water quality and nutrient load assessment;
- natural hazards;
- climate change;
- natural systems;
- cumulative effects; and
- assessment of land use and management scenarios.

The scope of work undertaken in Phase 2 will depend on local watershed conditions, work already completed on a watershed basis, the applicable policy context, and identified issues and goals.

Phase 3 will:

Develop a plan that will provide

- areas to be protected, enhanced and rehabilitated;
- various types/intensities of proposed development and development criteria;
- water, wastewater and stormwater servicing requirements (existing and future) and related water supply and assimilative capacity needs;
- land and water use management practices and performance measures;
- targets for protection and restoration of riparian areas;
- best management practices and designs for the management of the quantity and quality of surface water and ground water; and

- an implementation strategy to guide development, those responsible for designing and building recommended works at what time, and responsibilities and requirements for cost-sharing, future studies, monitoring and maintenance;
- direction for implementation in municipal official plan policies, informing land use planning and decision-making, and other implementation considerations; and
- a strategy for adaptive management, including ongoing monitoring.

2.2 PRINCIPLES

Watershed planning and subwatershed plans should be guided by commonly accepted and held principles underlying watershed and subwatershed planning, including the following:

Ecosystem Based Approach. The ecosystem approach recognizes the interdependence of land, air, water and living organisms, including humans. The ecosystem approach uses best available science, considers cumulative impacts, encourages conservation of resources and promotes watershed and sub-watershed approaches.

Landscape Based Analysis. A modern and sustainable approach to managing Ontario's natural resources by managing over broader areas and longer time periods. Elements include: managing at appropriate scales; integrating and coordinating; assessing, managing, and mitigating risk; focusing science and information resources; and managing adaptively.

Precautionary Approach. Caution will be exercised to protect the environment when there is uncertainty about environmental risks.

Adaptive Management. Continuously improve and adapt policies and management approaches by monitoring impacts, assessing effectiveness, and adjusting actions while considering new science, traditional ecological knowledge and innovative design, practices and technologies, and the need to adapt to a changing climate.

Sustainable Development. The right to development should be fulfilled to equitably meet economic and societal needs while not compromising the environment for present and future generations.

Collaboration and Engagement. Municipalities are encouraged to engage the public, Indigenous communities and stakeholders in local efforts to implement watershed planning, and to provide the necessary information to ensure the informed involvement of local citizens.

Recognition of Indigenous Communities. Indigenous communities maintain a spiritual and cultural relationship with water. Their identity, cultures, interests, knowledge and traditional practices are considered in watershed planning initiatives.

2.3 BRIEF HISTORY OF WATERSHED PLANNING IN ONTARIO

Watershed planning has been evolving in Ontario for decades. In the early 1900s, binational legislation such as the 1909 *Boundary Waters Treaty* recognized the need for water management on a watershed basis. Introduction of the Grand River Conservation Commission in 1932 and the subsequent enactment of the *Conservation Authorities Act* in 1946 represented the emergence of a watershed management framework in Ontario. Conservation authorities have since been established in 36 watersheds, including five in northern Ontario and 31 in southern Ontario.

Watershed management efforts in Canada largely focused on flooding, drought, water quality, erosion, and hazards until the 1970s. The 1972 *Great Lakes Water Quality Agreement* (GLWQA) addressed a number of emerging concerns, such as chemical contamination and aquatic habitats.

Master drainage plans in the 1980s had a main objective of managing development impacts, by addressing issues related to floodplain management, runoff quantity control, erosion and flood control works, major/minor system design, and culvert improvements. Through the 1980s and into the 1990s, objectives for environmental management shifted towards a subwatershed approach, with objectives to maintain and enhance natural systems, rather than simply avoiding development impacts. New issues were addressed in subwatershed studies, including water quality considerations, enhancement opportunities, and fisheries/aquatic habitat.

Since 1993, watershed planning has been guided by a trilogy of documents released by the province. *Water Management on a Watershed Basis: Implementing an Ecosystem Approach* provides an outline of the broad provincial context for a landscape approach to planning, and how the watershed management plan provides an appropriate avenue for integration of human activities and the hydrologic cycle. Subwatershed Planning describes the planning framework for subwatershed planning, direction for undertaking technical assessments, an outline of information needs, public participation considerations, and information to support monitoring programs. *Integrating Water Management Objectives into Municipal Planning Documents* provides guidance for the critical step of integrating watershed planning objectives into municipal planning documents and processes at various geographic scales.

In the early 2000s, the Walkerton Inquiry reignited engagement in a watershed approach to planning, specifically through a multi-barrier approach to protection of drinking water and the resultant source water protection planning processes that ensued. Ontario's Source Water Protection Program reached a significant milestone with all source water protection plans being approved by the Ministry of the Environment and Climate Change (MOECC) as of January 2016. The ORMCP, 2002 required municipalities to undertake watershed planning, which was supported by technical

guidance from the province. Development of the Lake Simcoe Protection Plan (LSPP) under the *Lake Simcoe Protection Act*, 2008, was a key achievement in watershed planning in Ontario.

2.4 CURRENT FRAMEWORK

Currently, Ontario's land use planning system is policy led, meaning that the province sets out the legislative and policy framework, which is then implemented by municipalities. The PPS provides province-wide direction on matters of provincial interest, including the protection and efficient management of water resources through watershed planning. Within the Greater Golden Horseshoe, the Growth Plan, Greenbelt Plan, ORMCP, and NEP offer more specific direction than the PPS.

The PPS requires that planning authorities shall 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, identifying water resource systems, and ensuring stormwater management practices minimize stormwater volumes and contaminant loads, among other requirements. Municipalities are encouraged to coordinate planning for ecosystem, shoreline, watershed, and Great Lakes related issues across municipal boundaries and with other orders of government, agencies, and boards.

Provincial land use plans that are applicable within the Greater Golden Horseshoe area provide direction for municipalities to ensure that watershed planning is undertaken to inform municipal policy and decision-making. Policies in the Growth Plan and Greenbelt Plan require that upper and single tier municipalities, in partnership with conservation authorities, as appropriate, shall ensure that watershed planning is undertaken to support a comprehensive, integrated, and long-term approach to the protection, enhancement or restoration of the quality and quantity of water within a watershed.

Policies in the Growth Plan and Greenbelt Plan include direction for:

- identification of a water resource system across the Greater Golden Horseshoe;
- strengthened requirements for watershed planning and subwatershed plans to inform land use planning and infrastructure decision-making; and
- requirements for water, wastewater, and stormwater master planning to be informed by watershed planning, among other requirements.

Note: the above list is not exhaustive and the applicable plans should be consulted for all policies that apply to watershed planning.

Policies in the ORMCP continue to require that upper tier and single tier municipalities have a watershed plan, which is implemented in the municipal official plan.

The approval framework for watershed planning and subwatershed plans has not changed as a result of the Coordinated Land Use Planning Review.

2.5 DEFINITIONS OF WATERSHED PLANNING

Watersheds. Watersheds are defined as an area that is drained by a river and its tributaries.

Subwatersheds. Subwatersheds are defined as an area that is drained by a tributary or some defined portion of a stream.

Figure 1 illustrates how water flows within a watershed. Natural processes and anthropogenic processes can result in impacts to hydrologic features, areas, and functions in a watershed.

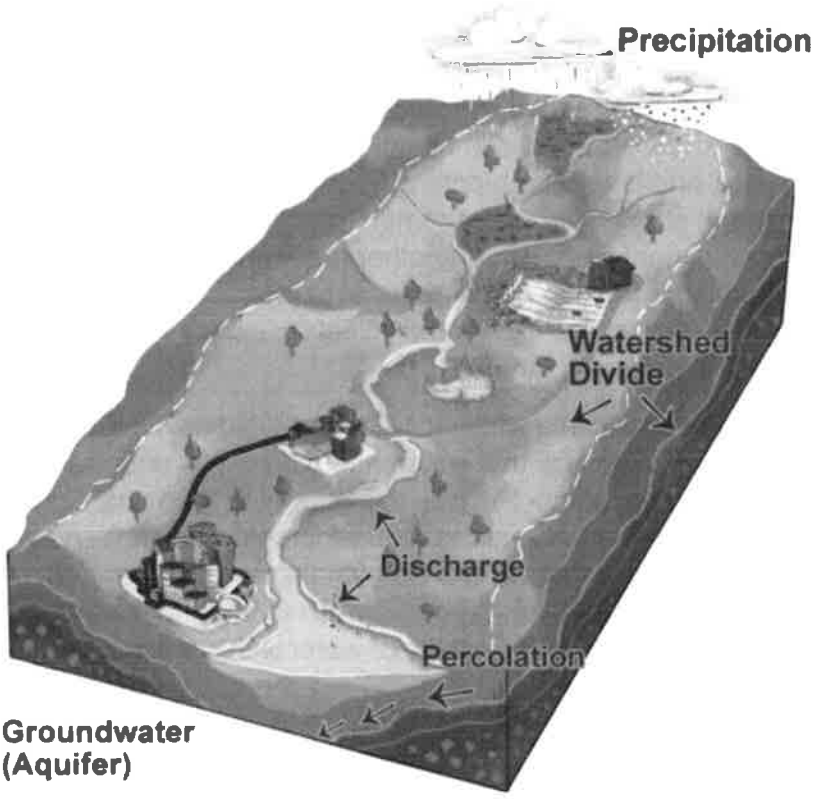


Figure 1 - A simple watershed with the boundary determined at the watershed divide

Watershed Planning

The Growth Plan and Greenbelt Plan share the same definition for watershed planning, which is defined as follows:

Watershed Planning
Planning that 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 a watershed and for the assessment of cumulative, cross-jurisdictional, and cross-watershed impacts.

Watershed planning typically includes: watershed characterization, a water budget, and conservation plan; nutrient loading assessments; consideration of climate change impacts and severe weather events; land and water use management objectives and strategies; scenario modelling to evaluate the impacts of forecasted growth and servicing options, and mitigation measures; an environmental monitoring plan; requirements for the use of environmental best management practices, programs, and performance measures; criteria for evaluating the protection of quality and quantity of water; the identification and protection of hydrologic features, areas, and functions and the inter-relationships between or among them; and targets for the protection and restoration of riparian areas.

Watershed planning is undertaken at many scales, and considers cross-jurisdictional and cross-watershed impacts. The level of analysis and specificity generally increases for smaller geographic areas such as subwatersheds and tributaries.

Subwatershed Planning

The Growth Plan and Greenbelt Plan share the same definition for subwatershed plan, which is defined as follows:

Subwatershed Plan

A plan that reflects and refines the goals, objectives, targets, and assessments of watershed planning for smaller drainage areas, is tailored to subwatershed needs and addresses local issues.

A subwatershed plan should: consider existing development and evaluate impacts of any potential or proposed land uses and development; identify hydrologic features, areas, linkages, and functions; identify natural features, areas, and related hydrologic functions; and provide for protecting, improving, or restoring the quality and quantity of water within a subwatershed.

A subwatershed plan is based on pre-development monitoring and evaluation; is integrated with natural heritage protection; and identifies specific criteria, objectives, actions, thresholds, targets, and best management practices for development, for water and wastewater servicing, for stormwater management, for managing and minimizing impacts related to severe weather events, and to support ecological needs.

Similarities and Differences across Provincial Plans

Definitions for watershed planning are consistent across the Growth Plan and Greenbelt Plan, but not the ORMCP. ORMCP policies in subsections 24(3), 24(4), and 24(8) in particular overlap with many components of watershed planning, except for: watershed characterization, nutrient loading assessments, and assimilative capacity respecting sewage. Watershed planning is not a defined term in the NEP and PPS, although the NEP does define watershed management.

Definitions for subwatershed plans are consistent across the Growth Plan and Greenbelt Plan, but not the ORMCP. ORMCP provides policies in subsections 27(1), 27(2), and 27(3) with respect to development and site alteration inside and outside of settlement areas in subwatersheds; the policies provide direction for percentage of subwatershed area covered by impervious surfaces and self-sustaining vegetation. Subwatershed plan is not a defined term in the NEP and PPS.

The following tables provide a comparison of watershed planning and subwatershed plan definitions across the Growth Plan and Greenbelt plan, compared to policies in subsection 24(3) of ORMCP:

Comparison of Watershed Planning Definitions and Policies

Watershed Planning	
Growth Plan & Greenbelt Plan	**ORMCP**
Planning that 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 a watershed and for the assessment of cumulative, cross-jurisdictional and cross-watershed impacts. • a water budget and conservation plan; • land and water use management objectives and strategies; • an environmental monitoring plan; • requirements for the use of environmental best management practices, programs, and performance measures; • criteria for evaluating the protection	24. (3) A watershed plan shall include, as a minimum: • (a) a water budget and a water conservation plan as set out in section 25; • (b) land and water use and management strategies; • (c) a framework for implementation, which may include more detailed implementation plans for smaller geographic areas, such as subwatershed plans, or for specific subject matter, such as environmental management plans; • (d) an environmental monitoring plan based on a minimum of five years of monitoring; • (e) provisions requiring the use of environmental management practices and programs, such as

of quality and quantity of water; • consideration of climate change impacts and severe weather events; • watershed characterization • nutrient loading assessments; • scenario modelling to evaluate the impacts of forecasted growth and servicing options, and mitigation measures; • the identification and protection of hydrologic features, areas and functions and the inter-relationships between or among them; and • targets for the protection and restoration of riparian areas.	programs to prevent pollution, reduce the use of pesticides and manage the use of road salt; • (f) criteria for evaluating the protection of water quality and quantity, hydrological features and functions, including criteria for evaluating the impacts of proposed development and infrastructure projects within and outside the Plan Area on water quality and quantity and on hydrological features and functions; • (g) an evaluation of the assimilative capacity of the watershed to deal with sewage from surrounding areas; • (h) an assessment of climate change impacts on sewage and water service systems and stormwater management systems.

Comparison of Subwatershed Plan Definitions and Polices

Subwatershed Plan	
Growth Plan & Greenbelt Plan	**ORMCP Policy**
A plan that reflects and refines the goals, objectives, targets, and assessments of watershed planning for smaller drainage areas, is tailored to subwatershed needs and addresses local issues. A subwatershed plan should: • consider existing development and evaluate impacts of any potential or proposed land uses and development; • identify hydrologic features, areas, linkages, and functions; • identify natural features, areas, and related hydrologic functions; • and provide for protecting, improving, or restoring the quality	27.(1) Except with respect to land in Settlement Areas, all development and site alteration with respect to land in a subwatershed are prohibited if they would cause the total percentage of the area of the subwatershed that has impervious surfaces to exceed, (a) 10 per cent; or (b) any lower percentage specified in the applicable watershed plan or subwatershed plan. 27.(2) Except with respect to land in Settlement Areas, in considering applications for development or site alteration with respect to land in a subwatershed the approval authority shall take into account the desirability of

and quantity of water within a subwatershed. A subwatershed plan: • is based on pre-development monitoring and evaluation; • is integrated with natural heritage protection; and • identifies specific criteria, objectives, actions, thresholds, targets, and best management practices for development, for water and wastewater servicing, for stormwater management, for managing and minimizing impacts related to severe weather events, and to support ecological needs.	ensuring that at least 30 per cent of the area of the subwatershed has self-sustaining vegetation. 27.(3) With respect to land in Settlement Areas, in considering applications for development or site alteration with respect to land in a subwatershed the approval authority shall consider the importance of, (a) ensuring that natural vegetation is maintained, and where possible improved or restored; and (b) keeping to a minimum impervious surfaces and their impact on water quality and quantity.

Municipalities need to follow direction outlined in the respective provincial plan, or policies that applies to them.

2.6 SUMMARY OF POLICY REQUIREMENTS

The key driver for watershed planning by municipalities is applicable policy direction of the PPS, Growth Plan, Greenbelt Plan, ORMCP, and NEP. The LSPP also provides requirements for watershed planning in the Lake Simcoe watershed.

Watershed planning in Ontario should also consider the *Great Lakes Protection Act* and Great Lakes Strategy, as well as water-related legislation, plans, and agreements.

In summary:

- **PPS policies encourage a coordinated approach to planning, within and across municipalities, on water, ecosystem, shoreline, watershed and Great Lakes matters. The policies require planning authorities to protect, improve or restore the quality and quantity of water by, among other things, using the watershed as the ecologically meaningful scale for integrated and long-term planning. The PPS is an outcome based policy document.**

- **Growth Plan and Greenbelt Plan policies require watershed planning to be undertaken to inform the protection of water resource systems and decisions related to planning for growth and subwatershed planning to inform site-specific land use planning decisions.**

- **ORMCP policies require watershed planning by municipalities, as well as development requirements based on impervious cover and natural cover in subwatersheds.**

- **NEP does not require watershed planning specifically, although approved watershed planning/subwatershed plans can inform land use, infrastructure, and development decision-making.**

- **LSPP applies to the Lake Simcoe watershed, which is defined in the *Lake Simcoe Protection Act.* The Plan speaks in detail about actions to be taken to protect and restore the ecological health of the Lake Simcoe watershed/subwatersheds.**

Refer to **Appendix A** for a summary chart of watershed planning/subwatershed plan requirements, and matters to be informed by watershed planning/subwatershed plans.

Checklists for Meeting Provincial Policy Requirements

Watershed planning components, as defined in the Growth Plan and Greenbelt Plan, are typical, or recommended components to provide municipalities with flexibility. Watershed plans must always be properly scoped to reflect local circumstances, capacity and reflect existing equivalent studies. However, in ORMCP, watershed plan contents as provided in 24(3) are required as a minimum. Municipalities may consider integrating requirements under ORMCP with components outlined in Growth Plan and Greenbelt Plan definitions, to ensure adequate consideration of cross-jurisdictional and cross-watershed impacts of growth, development, and infrastructure across plan areas.

The following table provides a consolidated list of watershed planning elements and the corresponding policy basis across the PPS and land use plans, organised by elements of the watershed planning process:

Matrix of Watershed Planning Policy Direction

****Note: Consult applicable provincial policies or plans to ensure complete requirements are met. This is only an overview of policies and their applicability to watershed planning.***

If a definition is listed, it means that element is a component of the definition.

Watershed Planning Element	Growth Plan	Greenbelt Plan	ORMCP	NEP	PPS
3.1 Effective Engagement & Committees					PPS 1.2.1.e

Watershed Planning Element	Growth Plan	Greenbelt Plan	ORMCP	NEP	PPS
3.2 Partnering with Indigenous Communities					PPS 1.2.2 & 4.3
4.1 Delineation of Watersheds & Subwatershed for Land Use Planning	Growth Plan 4.2.1.1	Greenbelt Plan 3.2.3.2 & 3.2.6.1.c & 3.2.6.2.c	ORMCP 24		PPS 2.2.1.a
4.2 Identification of the Water Resource System	Growth Plan definition & 4.2.1.2	Greenbelt Plan 3.2.3.3 (protected countryside only) & 5.3			PPS 2.2.1.c & 2.2.1.d
4.3 Characterization of Existing Conditions	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)d		
5.1 Vision, Objectives, Goals & Targets	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)b and 24(3)f		
6.1 Water Quantity, Water Budget & Water Conservation Plans	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)a (as set out in ORMCP 25)		PPS 2.2.1.f
6.2 Water Quality & Nutrient Load Assessments	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)g		PPS 2.2.1.g & 2.2.1.h
6.3 Natural Hazards in Watershed Planning & Subwatershed Plans					PPS 3.1.3

Watershed Planning Element	Growth Plan	Greenbelt Plan	ORMCP	NEP	PPS
6.4 Climate Change & Watershed Management	Growth Plan definition, 3.2.1.2.d & 3.2.1.4	Greenbelt Plan definition	ORMCP 24(3)h		
6.5 Connections to Natural Systems	GP 4.2.3.2 & 4.2.4.5	GB 3.2.5 & 3.2.6			
6.6 Cumulative Effects Assessment	Growth Plan definition and 3.2.6.4	Greenbelt Plan definition & 3.2.3.5			PPS 2.2.1.a & 2.2.1.b
6.7 Assessment of Land Use & Management Scenarios	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)f		
7.3 Informing Land Use Planning & Decision Making	GP 3.2.1.2				
7.3 Informing Land Use Planning & Decision Making	Growth Plan 2.2.8.3.e & 4.2.1.3	Greenbelt Plan 3.4.3.3 & 3.2.3.4		NEP 1.6.8, 1.7.5, 2.6 & 2.6.3	
7.4 Implementing the Watershed & Subwatershed Plan	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)c & 24(3)e	NEP 2.6.9	PPS 2.2.1 & 2.2.2
8 Monitoring & Adaptive Management	Growth Plan definition	Greenbelt Plan definition	ORMCP 24(3)d		

Interconnections with Other Policies and Strategies

Watershed planning is inherently connected to other provincial policies and strategies regarding natural heritage systems, as well as climate change, wetlands, biodiversity, agricultural systems, source water protection, stormwater management, shorelines, natural hazards, and Great Lakes water quality and ecosystem health. These other

policies and strategies inform objectives and actions in watershed and subwatershed plans.

Natural Heritage. Ontario's regional Natural Heritage System (NHS) contains natural heritage features, natural heritage areas, and linkages intended to provide connectivity and support natural processes which are necessary to maintain biodiversity and ecosystems. Ontario`s regional NHS applies to the Growth Plan areas outside of the Greenbelt Plan and settlement areas. Characterization of watersheds as a part of watershed planning typically considers natural heritage features and linkages, and their connections to hydrologic features and areas. The *Natural Heritage Reference Manual* (NHRM) provides guidance for implementing natural heritage policies of the PPS, which can be useful to consider in watershed planning. *How Much Habitat is Enough?* (HMHE?) can also assist with municipal target-setting.

Natural Hazards. Natural hazards, such as flooding hazards and erosion hazards, affect all regions of Ontario. On the Great Lakes shoreline, dynamic beaches are also considered as hazards. *Understanding Natural Hazards* provides introductory information on the Great Lakes-St. Lawrence River System and large inland lakes, as well as river and stream systems hazardous sites.

Climate Change. Climate change and the impacts of severe weather events must be considered in watershed planning (see Section 6.4 for more details). Ontario released its Climate Change Strategy in 2015, followed by Ontario's five-year Climate Change Action Plan, which aims to fight climate change, reduce greenhouse gas pollution and transition to a low-carbon economy over the long term. Environmental Assessment processes and planning processes need to consider the effects of a changing climate. MNRF has also released a *Guide for Assessment of Hydrologic Effects of Climate Change in Ontario*, which addresses climate change impacts on water resources. The Lake Simcoe Climate Change Adaptation Strategy, released in February 2017, takes a multi-faceted approach to drive actions in the Lake Simcoe watershed to adapt to our changing climate. Actions to address climate change and its impacts are being implemented throughout the watershed in collaboration with a range of stakeholders.

Wetlands. The *Wetlands Conservation Strategy for Ontario 2017-2030* provides a framework to conserve wetlands across the province, and identifies actions for the provincial government to undertake. A guiding principle of the strategy is that wetlands are integral components of their watersheds, natural heritage and hydrologic features and areas, and part of the larger landscape.

Biodiversity. *Biodiversity: It's in Our Nature 2012-2020* aims to reduce threats to biodiversity and enhance resilience, which includes landscape-level conservation planning and promotion of urban biodiversity and green infrastructure strategies.

Source water protection. Source water protection plans are required under the *Clean Water Act*, 2006. They identify areas where an activity is or would be a significant drinking water threat, through assessment reports, and then provide policies and

approaches to protect against significant drinking water threats. Assessment reports and water budgets prepared in support of source water protection plan development provide information for understanding watersheds and threats to water quality and quantity. Source protection committees, conservation authorities, environmental organizations, and municipalities all have important roles in implementation of source water protection in Ontario.

Stormwater Management. A shift towards an ecosystem-based water balance approach to stormwater management has emerged in Ontario, which is being successfully applied. Green Infrastructure (GI) and Low Impact Development (LID) have emerged as new approaches and techniques in stormwater management, which are also supported by provincial land use policies. Watershed planning and subwatershed plans will inform stormwater master plans, water and wastewater master plans, and stormwater management plans.

Great Lakes. The Great Lakes Water Quality Agreement (GLWQA) was originally signed in 1972 to commit Canada and the United States to coordination of actions to restore the chemical, physical, and biological integrity of the waters of the Great Lakes basin. The GLWQA was amended in 2012 to identify new priority challenges, including: aquatic invasive species, habitat and species, and climate change impacts. A new focus on nearshore areas and adaptive management is articulated in the updated GLWQA. The Canada-Ontario Agreement (COA) on Great Lakes Water Quality and Ecosystem Health 2014 assists with protecting waters from high nutrient levels, harmful pollutants, and invasive species. Phosphorus reduction in the Lake Erie basin is a priority outlined in the proposed Canada-Ontario Action Plan for Lake Erie. The *Great Lakes Protection Act,* 2015 provides a framework to protect and restore the health of the Great Lakes-St. Lawrence River basin. The Great Lakes Strategy provides direction on actions to protect the Great Lakes-St. Lawrence River basin, as new threats and stressors are resulting in cumulative impacts that are diminishing the adaptive capacity of the Great Lakes. The Strategy recognizes challenges facing the Great Lakes across various areas, including: growth, natural heritage, invasive species, climate change, chemicals of emerging concern, water levels, algae, and beaches.

2.7 ROLES & COORDINATION

Municipal Role

Across the Province, there will be differences in scope, scale, and complexity of watershed planning and subwatershed plans, which need to be addressed. Some municipalities might have a footprint in multiple watersheds or a given watershed might contain all or part of multiple municipalities. Provincial policies direct planning authorities to coordinate planning matters and consider cross-jurisdictional and cross-watershed impacts.

Management at a watershed scale has traditionally been undertaken by conservation authorities, where they exist. In southern Ontario, particularly in the Greater Golden Horseshoe area, conservation authorities have experience in watershed management, and many upper-tier and single-tier municipalities have included policies in their official plans to implement watershed planning. Conservation authorities have differing levels of resources and financial support, depending on their proximity to populated urban areas with development pressures. However, in the Greater Golden horseshoe area, where development pressure is high, conservation authorities can be valuable partners in planning and implementation efforts, especially beyond the scope of land use policy direction.

Upper and single-tier municipalities and partner organizations in the Greater Golden Horseshoe will need to coordinate watershed planning across jurisdictional boundaries. Municipalities can partner with conservation authorities to undertake watershed and subwatershed planning, where conservation authorities exist, at municipal discretion. In southern Ontario, coordination of watershed planning has largely been organized by conservation authorities in the past, although other models and approaches do exist, such as community-based environmental organizations, committees established under legislation, Joint Services Boards, and others.

Coordination must be accompanied by clearly articulated objectives with an explicit decision-making framework that is involved with purposeful data. Development of agreements or clear Terms of Reference for watershed planning and subwatershed plan development among stakeholders, participants, and agencies will be useful for coordinating roles and tasks. The use of various committees or working groups, with clear leadership for multi-jurisdictional coordination, will support watershed planning endeavours, as outlined in **Section 3.1** of the Watershed Planning Guidance.

A 'layered' approach which first considers the broadly applicable PPS, then provides additional layers of watershed planning elements in the Greater Golden Horseshoe area, can assist with addressing regional variations in scope and complexity of watershed planning undertakings. Within the GGH, if the plans are silent on a matter the municipality must defer to the PPS for direction. PPS is a legislative requirement and must always be considered. The PPS provides overall policy directions on matters of provincial interest related to land use and development in Ontario, and applies to the GGH, except where the Growth Plan or another provincial plan provides otherwise. Additionally, if there is a conflict between the Growth Plan and the PPS, the Growth Plan prevails unless the conflict is between policies relating to the natural environment or human health. In that case, the direction that provides more protection to the natural environment or human health prevails.

Provincial Role

Existing and updated policies in the Growth Plan and Greenbelt Plan include requirements for watershed planning and subwatershed planning to inform land use

planning and infrastructure decisions. The Province has a role in reviewing land use planning and infrastructure decisions to ensure that they are informed by watershed or subwatershed planning. Following are some examples of this:

The provincial One Window Planning Service is the process whereby the Ministry of Municipal Affairs provides municipalities, municipal planning authorities, planning boards, developers and the public with one-stop access for provincial planning services. The provincial One Window Planning Service will review applicable land use planning decisions (eg. Official Plans and Plans of Subdivision) to ensure that they have been informed by watershed planning in accordance with this guidance document.

The Ministry of Environment and Climate Change also has approval and/or review authority over environmental assessments for water-related infrastructure decisions (eg. water and wastewater master plans and stormwater master plans) under the Environmental Assessment Act and approvals for new or expanded infrastructure of this type under the Environmental Protection Act and Ontario Water Resources Act. During this review and approval process, MOECC may review these decisions where appropriate to ensure that they have been informed by watershed planning in accordance with this guidance document.

2.8 EQUIVALENCY & TRANSITION PROVISIONS

The Growth Plan and Greenbelt Plan speak to allowing equivalent master plans, assessments and studies to be used by municipalities and planning authorities to inform land use and infrastructure planning and decision-making. Equivalent studies are collectively, existing, enhanced, or new assessments, studies, and plans, provided that they achieve or exceed the same purposes as required by policies within the plans. Municipalities and planning authorities should assess the components of watershed planning that are outlined in this section and determine whether the assessments and studies they currently have would meet the components required under each plan. If not, then the assessments and studies need to be updated accordingly.

While developing a watershed or subwatershed plan, municipalities and planning authorities can use equivalent studies to inform their planning and decision-making.

The terms watershed planning, subwatershed plan, water and wastewater master plan, and stormwater master plan are defined in provincial plans. However, the use of "or equivalent" provides flexibility while ensuring the intent of these terms is maintained.

At its core, an equivalent study to watershed planning will need to: use the watershed as the logical ecological scale for planning; identify and provide for protection of water resource systems including key hydrologic features, areas, functions and interrelationships; and consider existing and proposed land uses and developments, development criteria and associated impacts on quality and quantity of water. Subwatershed plans may be considered partially equivalent to watershed planning, provided that they achieve or exceed the same purposes and are protective of water at

the broader watershed scale, since they refine the goal, targets, and assessments of watershed planning for smaller drainage areas, and are based on pre-development monitoring and evaluation.

3 Engagement and Indigenous Perspectives

3.1 EFFECTIVE ENGAGEMENT & COMMITTEES

What is it?

Engagement is about the communication and outreach activities undertaken to deliver on a particular proposal or project. In the case of watershed planning, municipalities and watershed practitioners should establish an approach to public, stakeholder, and Indigenous engagement at the outset of developing a watershed plan.

Why is it important?

Engagement can support a sense of ownership in the watershed planning process by participants and stakeholders. Engagement also provides opportunities for public education and outreach, as well as data collection through citizen science. Engagement of communities is important for relationship building and stewardship.

Engagement of communities, interested parties, agencies, all levels of government, and Indigenous communities will be vital to a successful watershed planning process, and to support long-term, ongoing implementation, monitoring, and adaptation. Engagement is a flexible process ranging from general information sharing to meaningful dialogue and collaboration. The scope and objectives of engagement will vary depending on the level of interest from stakeholders and Indigenous communities.

Public involvement in plan development increases the likelihood of public understanding of and support for the plan. This support translates directly into stakeholder willingness to advance the plan, fund plan implementation, and to carry out their mandates/responsibilities in accordance with the plan.

Provincial policies encourage a coordinated and integrated approach to watershed planning, in which, municipalities of all levels work with other orders of government, Indigenous organizations, agencies, boards and conservation authorities. As such, engagement activities need to consider roles and responsibilities of the various stakeholders.

How to do it?

Engagement is not limited to the development of the watershed plan and its subsequent incorporation into municipal policies – there are roles across the planning, implementation, monitoring, and adaptive management aspects of the watershed planning framework.

Municipalities and planning authorities can partner with other groups in carrying out watershed and subwatershed planning, including conservation authorities, watershed councils, environmental organizations, committees, and other organizations within and outside of government.

The conservation authority model is one approach for integration across scales and jurisdictions in southern Ontario; however, where there is no conservation authority, other environmental organizations are usually needed to facilitate a similar level of coordination on a watershed basis. Engagement with source water protection committees and regions will be helpful to avoid duplication and build on successes.

Developing an Effective Engagement Strategy

Step 1: Establishing Your Steering Committee and/or Working Groups

- Determine membership:
    - Municipality(ies)
    - Planning authorities
    - Conservation authorities
    - Indigenous communities and organizations
    - Watershed councils and/or source protection committee
    - Government Ministries and/or Agencies
    - Environmental organizations
    - Other interest groups
- Prepare a Terms of Reference
- Define study area

Once your committee and/or working groups are established you can begin to develop an engagement strategy as part of your watershed planning process. The committee and/or working groups will be effective avenues for integrating a range of partners throughout the watershed planning process.

As you progress through the watershed planning process, you may want to establish topical/subject matter working groups to address particular components of the watershed plan. These topical working groups could then report to the steering committee.

***Note:** It is important to ensure appropriate and meaningful Indigenous involvement. Indigenous representation on a steering committee may help to inform an appropriate

Indigenous engagement approach for communities and organizations. See **Section 3.2** for more details.

Step 2: Engagement Planning

Your steering committee and/or working groups may not necessarily include all possible interested stakeholders. You will need to develop an engagement strategy to ensure you engage all potentially affected stakeholders and interested members of the public within your watershed area.

Your engagement strategy should:

- Describe your methods of engagement (written notification, one-on-one meetings, public meetings, workshops, online surveys, watershed tours, etc.);
- Outline a frequency of engagement for relevant and timely information sharing;
- Establish a process for interested stakeholders or individuals to raise concerns or issues, and provide suggestions or recommendations;
- Outline anticipated timelines and opportunities for additional engagement; and
- Establish how you intend to address feedback received.

Engagement Best Practices:

- Be respectful and transparent
- Be very clear about intentions and expectations
- Know your audience and design engagement materials around them
- Consider cultural and linguistic differences
- Maintain regular communication with all interested parties to foster good relationships
- Identify human and financial resources required at an early stage to carry-out effective engagement

***Note:** There may be an opportunity to align watershed engagement activities with regular municipal planning processes. For example, public open houses for official plan reviews and amendments could be scheduled to coincide with key points of the watershed planning process.

Step 3: Engagement Record

An engagement record outlines details of all engagement activities. It is useful to keep a record of all feedback received and how issues were addressed. This will help to ensure a representative and collaborative final product.

Example Engagement Record Template:

Name of Organization/ Individual/Community	Date of Engagement	Overview of Issues/ Concerns/ Recommendations	Response

Step 4: Conduct Effective Engagement

Carry out your engagement activities as outlined in your engagement strategy. If issues arise, be prepared to adapt your original plans. Maintain your engagement record and report back to interested stakeholders and Indigenous communities on the results of your engagement and how that engagement affected the plan.

Involving the Public

During watershed characterization and/or monitoring it may help to involve community groups in data collection to ensure effective and efficient implementation. This can be achieved through the use of citizen science.

Citizen Science. The collection and analysis of data by members of the general public in collaboration with professional scientists.

In undertaking watershed planning, involvement with existing citizen science networks and protocols can be beneficial. Also, new citizen science programs can be established for the specific watershed.

3.2 PARTNERING WITH INDIGENOUS COMMUNITIES

What is it?

A partnership approach with Indigenous peoples can lead to a more comprehensive watershed plan.

Indigenous peoples in Ontario consist of numerous First Nations and Métis communities and peoples.

Ontario is covered by many treaties and other agreements. Understanding treaty areas and the locations of First Nation communities is important for watershed planning.

First Nations and Treaties maps are available through the Government of Ontario.

More information on First Nations in Ontario can be obtained by contacting Chiefs of Ontario, or from other Provincial and Territorial Organizations that a local First Nation may be part of.

More information on Métis in Ontario can be obtained by contacting the Métis Nation of Ontario, or through liaising with Independent Métis communities.

Why is it important?

Relationship building and meaningful engagement with Indigenous peoples is important for watershed planning. Municipalities should recognize and respect Indigenous communities' relationship to, and customary stewardship of, land, water and resources, and the specific knowledge and history they can bring to watershed planning. Working with Indigenous partners helps to promote respectful and mutually beneficial relationships in the management and protection of watersheds.

Examples of Declarations Recognizing the Importance of Indigenous Partnerships:

- **United Nations Declaration on the Rights of Indigenous Peoples** – is a comprehensive statement addressing the human rights of Indigenous peoples. The values reflected in the Declaration are consistent with Ontario's approach to Indigenous relations and reconciliation, which is rooted in a commitment to establish and maintain constructive, co-operative relationships based on mutual respect that lead to improved opportunities for all Indigenous peoples.
- **Water Declaration of the Anishinaabek, Mushkegowuk and Onkwehonwe** – in 2008, the Chiefs of Ontario released the Water Declaration. The Water Declaration speaks to the relationship of First Nation peoples to the waters, the condition of the waters, water rights and treaties and self-determination.

Potential Risks of Ineffective Indigenous Engagement:

- Inadequate consideration of traditional ecological knowledge could lead to incomplete watershed planning information
- Loss of community support for plan
- Potential delays to project developments

How to do it?

Municipalities are encouraged to work with Indigenous communities who may be interested in and affected by watershed planning. Municipalities should reach out to local Indigenous communities within the watershed, as well as Indigenous communities that have traditional or treaty rights in the watershed – some of these communities may

be located relatively far from the subject watershed (refer to the referenced First Nations and Treaty maps, or contact Chiefs of Ontario and Métis Nation of Ontario). In-person visits, phone calls, emails and letter circulation can help with determining if there is an interest in working together and how this will be accomplished. **Early engagement is vital. Interested, or potentially affected, Indigenous communities should be partners in watershed planning.**

It is important to remember that many Indigenous communities and their staff often face resource and capacity pressures. Municipalities should consider how to equitably partner with Indigenous communities. **Meaningful Indigenous engagement can lead to a more comprehensive and robust watershed plan.**

Indigenous Engagement Best Practices:

- Early engagement is vital and contact with Indigenous communities should be made prior to commencement of watershed planning
- Meaningful representation on steering committees/watershed planning governance structures
- Consideration of traditional ecological knowledge, if offered
- Support for capacity building through watershed planning development and implementation
- Discuss with each Indigenous community how best to work together
- Learn from each other and foster relationship building

Partnership/Collaboration:

- Explore development of stewardship programs that support Indigenous community studies, restoration and involvement, with a focus on Elders, women and youth participation
- Further develop conservation partnerships with Indigenous communities to encourage conservation, implement best management practices and identify restoration opportunities within watersheds
- Work with Indigenous communities to develop targeted initiatives and materials, and include Indigenous perspectives in watershed awareness initiatives
- Involve Indigenous communities in environmental monitoring to provide input into current and future watershed planning efforts
- With respect to water quality and quantity, share information and promote opportunities to work collaboratively with Indigenous communities to address the maintenance of water quality and quantity within watersheds
- Provide opportunities for Indigenous youth to network with non-Indigenous youth in municipalities regarding watershed planning
- Promote mentorship opportunities for Indigenous youth to meet and work with experienced individuals with expertise in watershed management

Traditional Ecological Knowledge

Respectful consideration of traditional ecological knowledge in watershed planning undertakings, as appropriate, can contribute to positive environmental management outcomes and relationship-building.

Effective engagement with Indigenous communities may include the consideration of traditional ecological knowledge as part of watershed delineation and characterization. This knowledge can, for example, help determine historical water levels, historical and cultural land uses, significant cultural sites, ecologically sensitive areas and important times of year for a variety of species. Traditional ecological knowledge may help to define research questions and data collection for any monitoring programs.

Municipalities should discuss with the appropriate Indigenous knowledge holders how traditional ecological knowledge may be shared and how it may be used.

Indigenous Watershed Planning Resources

The Centre for Indigenous Environmental Resources (CIER) has created a series of *First Nations Integrated Watershed Planning Guidebooks.* These can be useful resources on the topic of Indigenous involvement in watershed planning.

Examples of Indigenous Engagement in Watershed Planning Initiatives:

Georgina, Fox and Snake Islands The subwatershed plan for Georgina, Fox, and Snake Islands was prepared in partnership with Chippewas of Georgina Island First Nation, and provides a case study for coordinated, integrated planning among municipalities, conservation authorities, the public, and First Nations communities.
Greater Sudbury Source Protection Plan (2014) The *Clean Water Act, 2006* prescribes a multi-stakeholder, science-based process for source protection planning. In 2007, the Greater Sudbury Source Protection Committee was established to guide source protection planning for this region. Both First Nations communities in the Greater Sudbury area (Atikameksheng Anishnawbek and Wahnapitae First Nations) had representatives on the Committee.

4 Watershed Delineation & Characterization

Watershed delineation and characterization consists of three core components:

- Delineation of Watersheds and Subwatersheds for planning and management
- Identification of the Water Resource System
- Characterization of Existing Conditions

4.1 DELINEATION OF WATERSHEDS & SUBWATERSHEDS FOR LAND USE PLANNING

What is it?

Watershed delineation involves the identification of watershed, subwatershed, and/or catchment area boundaries for planning and management purposes. Fundamentally, watersheds and subwatersheds can be delineated based on drainage basin divides.

Why is it important?

Watershed scale planning provides a foundation for municipalities to protect the quality and quantity of water based on logical ecological boundaries, and to consider cross-jurisdictional and cross-watershed impacts. Watershed boundaries often cross over multiple political jurisdictions, such as municipal boundaries, since they are based on functional drainage areas in the natural environment.

Watershed planning typically includes smaller nested drainage areas, such as subwatersheds and tributaries, so these boundaries should be identified through watershed planning. In many watershed planning processes undertaken to date in southern Ontario, priority subwatersheds are identified for further studies and management efforts, especially in areas subject to high development pressure or ecosystem degradation.

Where watershed planning typically focuses on geographically large units (> 1000 km^2), subwatershed planning provides for a more detailed approach to planning based on a local subbasins. Stormwater management planning, planning for designated greenfield areas and planning for major development/large-scale development will typically be based on smaller geographic basins such as subwatersheds.

How to do it?

Step 1: Determine watershed boundaries based on existing data

Watershed delineation will typically be based on existing boundaries mapped through ongoing provincial, municipal, or conservation authority efforts. For example, upper-tier municipalities and conservation authorities typically have existing GIS mapping or shapefiles available for watersheds, subwatersheds, and smaller drainage catchments. Subwatershed studies and master environmental servicing plans undertaken in support of development and land use change should also be consulted for existing watershed boundaries.

The Ontario Flow Assessment Tool (OFAT) can be used to assist in watershed delineation as part of municipal watershed planning. Figure 2 demonstrates the boundaries of Ontario's primary watersheds, secondary watersheds, and tertiary watersheds, as mapped using OFAT.

Figure 2 - Ontario Flow Assessment Tool

Watershed-based organizations in Ontario are generally based around tertiary watersheds or smaller geographic. Municipalities may choose to work with conservation authorities and watershed-based environmental organizations to confirm the boundaries of smaller drainage basins.

Delineation can also be undertaken manually using topographic mapping to establish drainage basins. Using paper mapping or GIS tools, municipalities and watershed practitioners can identify drainage areas based on surface water drainage patterns and topographic boundaries and features.

Watershed Information Sources

Municipalities and watershed practitioners are encouraged to maximize the use of existing information as opposed to carrying out exhaustive new studies and inventories.

In using existing information and inventories, practitioners should identify crucial gaps in information and establish programs to acquire this information.

Watersheds and subwatersheds can be delineated and characterized using data and information available from the province, environmental organization, conservation authorities, municipal studies, and other sources. There is a wealth of existing information to assist municipalities in identifying watershed and subwatershed boundaries and characterizing features and functions, including:

- Land Information Ontario (LIO) – primary, secondary, tertiary, and quaternary watersheds;
- OFAT – create watershed maps, characterize the watershed, estimate stream flows;
- MNRF Arc Hydro Quaternary Watersheds – Consult MNRF Guidelines for Getting Started with MNRF's Arc Hydro Quaternary Watershed Sessions for detailed instructions;
- Conservation authority watershed and subwatershed mapping, publications, and GIS files;
- Source protection assessment reports and Water Budgets prepared as part of source protection planning; and
- Existing watershed plans, subwatershed plans, water and wastewater master plans, stormwater master plans, environmental impact studies, sustainability plans, etc.

4.2 IDENTIFICATION OF THE WATER RESOURCE SYSTEM

What is it?

As part of watershed characterization, water resource systems need to be identified, depending on the applicable policy framework in the watershed or subwatershed (PPS, Growth Plan, or Greenbelt Plan). ORMCP and NEP do not specifically outline components of water resource systems; however, natural heritage systems and hydrologic features of the ORMCP and NEP are significant elements of water resource systems in the province.

PPS

The water resource system, as provided in PPS policies, is a system which consists of:

- **ground water features**;
- **hydrologic functions**;
- **natural heritage features and areas**;
- **surface water features**, including shoreline areas;

Growth Plan

The *water resource system*, as defined in Growth Plan, is a system which consists of:

- **ground water features and areas**;
- **surface water features (including shoreline areas)**;
- **hydrologic functions**, which provide the water resources necessary to sustain healthy aquatic and terrestrial ecosystems and human water consumption; and
- The water resource system will comprise **key hydrologic features** and **key hydrologic areas**.

Greenbelt Plan

The *water resource system*, as provided in Greenbelt Plan, is a part of the Protected Countryside's Natural System, along with the NHS.

The water resource system is comprised of both **ground and surface water features and areas** and their **associated functions**, and it provides the water resources necessary to sustain healthy aquatic and terrestrial ecosystems, as well as human water consumption. **Areas of hydrological significance** in the Greenbelt function together with **other hydrological features and areas** within the remainder of watersheds that extend outside of the Greenbelt, to form water resource systems. These areas of hydrological significance could include:

- The upper reaches of watersheds draining to Lake Ontario to the west of the Niagara Escarpment;
- Lands around the primary discharge zones along the toe of the Niagara Escarpment and base of the Oak Ridges Moraine;
- The major river valleys that flow from the Oak Ridges Moraine and the Niagara Escarpment to Lake Ontario;
- The portions of the Lake Simcoe watershed and the former Lake Algonquin Shoreline within York and Durham Regions; and
- The former Lake Iroquois shoreline in Durham and Niagara Regions.

Water Resource System Components

Please refer to the applicable provincial policy or plan for definitions of water resource system components.

Why is it important?

Water resource systems, similar to natural heritage systems, provide a systems-based approach to protection of valuable ecosystems and functions.

Planning authorities shall protect, improve or restore the quality and quantity of water by:

- identifying water resource systems consisting of ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas, which are necessary for the ecological and hydrological integrity of the watershed (PPS 2.2.1.c);
- maintaining linkages and related functions among ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas (PPS 2.2.1d); and,
- implementing necessary restrictions on development and site alteration to: protect all municipal drinking water supplies and designated vulnerable areas; and, protect, improve or restore vulnerable surface and ground water, sensitive surface water features and sensitive ground water features, and their hydrologic functions (PPS 2.2.1.e).

Growth Plan and Greenbelt Plan provide that water resource systems will be identified, informed by watershed planning and other available information, and the appropriate designations and policies will be applied in official plans to provide for the long-term protection of key hydrologic features, key hydrologic areas, and their functions (Growth Plan 4.2.1.2 & Greenbelt Plan 3.2.3.3).

How to do it?

Step 1: Determine what information already exists and identify gaps

Many features of the water resource system have been identified through municipal natural heritage planning, the provincial Natural Heritage System, source protection planning, environmental studies supporting development applications, conservation authority watershed management and monitoring, and other studies and reports.

Existing information is available in source protection plans and assessment reports, as well as municipal official plan schedules. Existing information may be available from other municipal plans and studies, as well as conservation authorities. The provincial NHS will be considered in watershed planning processes at the municipal level.

Step 2: Undertake reviews or studies to identify water resource system features

Where information does not exist, field studies may be required. A range of accepted protocols for identification of these features and areas, such as OSAP, OWES, and ELC classification, can be used.

As provided in the definitions for **ground water features**, these features can be defined by surface and subsurface hydrogeologic investigations.

As identified in the definition for **surface water features**, these features can be defined by their soil moisture, soil type, vegetation or topographic characteristics.

Methods for identifying and protecting water resource system features are outlined in source protection plans (and associated assessment reports and water budgets), ORMCP Technical Papers, and various conservation authority-published supplemental technical guidelines.

Methods for identifying and protecting these features are also outlined in the NHRM, HMHE?, *Significant Wildlife Habitat Technical Guidelines* (and updated eco-region criteria schedules), *ORMCP Technical Papers,* and various conservation authority-published supplemental technical guidelines.

To assist with identification of significant groundwater recharge areas, MNRF and North Bay Mattawa Conservation Authority published *Delineation of Significant Groundwater Recharge Areas Supplemental Technical Guide* to assist with identification and protection of these significant areas. Municipalities should consult the Technical Guide for direction in delineating SGRAs. In the *Technical Guide,* guidance is provided for identification of SGRAs, including information regarding: SGRA thresholds, spatial scale for averaging, linking high recharge areas to a drinking water system, and professional judgement relating to SGRAs (smoothing/infilling, modifying mapping based on geologic features, discharge areas, and wellhead capture zone considerations). The *Technical Guide* also provides a section regarding secondary analysis to confirm SGRA thresholds, as well as a section regarding refinements of SGRAs, and a section outlining other SGRA considerations. It is noted that all information contained in the supplemental *Technical Guide* is based on information taken from Assessment Reports prepared under the *Clean Water Act* and supporting Water Budget and Risk Assessment Reports.

Step 3: Identify functions and interrelationships

Identification of functions requires consideration of relationships and water-related dependencies, as well as consideration of factors which may influence viability of water resources.

With key features identified, there is now a need to determine functions and linkages within the system. One method of completing this is through concept mapping within a **pressure-state-response framework**. Watershed and subwatershed studies undertaken to date in Ontario often utilize a pressure-state-response framework which: describes the current condition (state), describes the stressors likely leading to the current condition (pressure), and recommends management responses in the context of the current management framework (response). At this stage in watershed planning, concept mapping will be used to determine the relationship between state and pressures. This information can be linked to management actions in later stages of the watershed planning process.

Step 4: Identify linkages to support connectivity

In natural heritage and watershed planning, areas with high concentrations of key features can be considered as 'core areas', and broader areas and connections can be identified as 'linkages' or 'corridors'.

Information for natural heritage system identification provided in *Development of the Proposed Natural Heritage System for the Growth Plan for the Greater Golden Horseshoe Summary of Criteria and Methods* will be useful to consider in undertaking watershed planning.

The *Natural Heritage Reference Manual* will also provide valuable information.

Core areas are the building blocks of an NHS and should be the most enduring natural areas within the landscape. Linkages provide the connections between core areas, which provide corridors and functional routes for the movement and viability of populations of plant and animal species. Linkages enable ecological processes to continue across a landscape by reducing habitat fragmentation and isolation.

Connectivity is the degree to which key natural heritage features are connected by species movement corridors, hydrological and nutrient cycling, genetic transfer, and energy flows through food webs. Connectivity between key features and areas can be supported through identification of existing and potential linkages. Watershed planning should endeavour to maintain or increase the level of connectivity between key hydrologic features and areas and key natural heritage features and areas. Geospatial analysis of core features and supporting features can provide a means of assessing connectivity.

Watershed Information Sources

- MNRF, 2010. Natural Heritage Reference Manual.
- ECCC, 2013. How Much Habitat is Enough?
- MNRF, 2000. Significant Wildlife Habitat Technical Guide.
- ORMCP, 2007. Technical Papers.
- MNRF Make a Map online tools
- MNRF, 2013. Water Budget Reference Manual.
- MNRF, 2013. Guide to Assessment of Hydrologic Effects of Climate Change.
- MNRF Lakeshore Capacity Assessment Handbook
- MOECC, 2003. Stormwater Management Planning and Design Manual.
- Southern Ontario Land Resource Information System (SOLRIS) - which is publicly available through Land Information Ontario (LIO).
- Jones, N.E. and B. Schmidt, 2017. Aquatic ecosystem classification system for Ontario's rivers and streams. Ontario Ministry of Natural Resources and Forestry,

Science and Research Branch, Peterborough, ON. Science and Research Technical Note TN-04. 19 p.

- Provincial Natural Heritage System and background studies.
- Completed watershed plans and subwatershed plans.
- Conservation authority mapping, monitoring data, and programs.
- Source Protection Planning Assessment Reports and background technical work.

4.3 CHARACTERIZATION OF EXISTING CONDITIONS

What is it?

Characterization is a vital component of watershed planning which involves establishing a baseline of existing watershed conditions. The baseline can be re-visited to evaluate progress towards environmental objectives and track success of management efforts. Existing conditions for quality and quantity of water will need to be determined, and locations and status of features and linkages will need to be identified, and then issues can be identified for further analysis.

Baseline characterization of a watershed is a necessary initial step which provides the foundation for ongoing watershed monitoring, and will include the collection of existing and/or new data directly related to various aspects of the watershed study area. By completing this initial step, water practitioners are empowered to both set realistic and achievable future program targets and track changes in the watershed over time under the context of adaptive management.

Watershed characterization includes:

- Describing the **Form**, **Function,** and **Linkages** within the watershed;
- Identifying **Issues and Opportunities**, especially regarding the need for protecting, restoring, or enhancing watershed features and functions;
- Prioritizing **Needs**; and
- Establishing Preliminary **Goals and Objectives**, which can be refined as the watershed planning process progresses

Watershed characterization should provide an image of the current conditions of indicators associated with quality and quantity of water, so impacts as a result of planning, development, and management actions can be evaluated and adaptively managed. Since the watershed scale is the ecologically-meaningful basis for integrated and long-term planning, and a foundation for considering cumulative impacts, watershed characterization should consider indicators outlined in the PPS definition for quality and quantity of water, including:

- minimum base flow;
- depth to water table;

- aquifer pressure;
- oxygen levels;
- suspended solids;
- temperature;
- bacteria; and
- nutrients and hazardous contaminants.

Characterizing the watershed can include a range of elements, depending on local watershed issues and conditions, such as:

- Identifying aquatic and terrestrial habitats;
- Identifying the quantity of surface and groundwater resources, relationships, and water related dependencies;
- Quantifying precipitation (rainfall and snowfall);
- Quantifying groundwater;
- Quantifying surface water,
- Identifying existing flow regimes (peak flow volume and rates);
- Identifying existing water balance (recharge areas, rates and sensitivity);
- Identifying features and functions of the natural heritage system (interconnections between and among aquatic, terrestrial and groundwater systems, buffers and linkages); and
- Identifying constraints (floodplains, steep slopes, erosion areas, wetlands, forests, habitat, corridors, buffers, wellheads).

Many examples of scoped watershed and subwatershed characterization studies currently exist, which provide models that municipalities can build on. For example, Central Lake Ontario Conservation Authority (CLOCAs) subwatershed plans and associated background studies are available on their website, and many of GRCA's previous and current studies are available in digital format upon request.

Why is it important?

Watershed characterization is an essential component of watershed planning, and provides the basis for developing goals and targets, evaluating land use and management scenarios, and developing management approaches. An understanding of the features, functions, and linkages within a catchment can also be used in monitoring effectiveness of management actions and ecological change.

Ecological monitoring can fill gaps in areas where there is no existing information or data available, especially in areas where growth and development are directed.

Watershed planning will take an integrated approach to identifying, protecting, and restoring key features and functions of the watershed.

How to do it?

Step 1: Determine what information is available, and what information is needed, to "paint a picture" of the state of the watershed

The use of existing data is encouraged, where it exists and is appropriate for the watershed. Monitoring and field work may be necessary to fill gaps in data.

Existing conditions for quality and quantity of water will need to be known, and locations and status of features and linkages will need to be identified, so that issues can be identified for further analysis.

Previously undertaken characterization studies, watershed monitoring and report cards, and environmental evaluations in support of planning and development applications may provide enough information to develop goals, targets, and actions; however, additional information may be needed to understand emerging issues and threats. Planning authorities should review all relevant information prior to developing a watershed monitoring program.

Watershed characterization provides information necessary for creating goals and targets (as outlined in **section 5**), undertaking more detailed watershed planning elements (as outlined in **section 6**), and assessing impacts, implementation progress, and adaptive management (as outlined in **section 7** and **section 8**).

Watershed planning elements outlined in **section 6** of the Watershed Planning Guidance are also associated with watershed characterization, depending on the needs and conditions of the watershed, and the policy frameworks which apply. Watershed characterization can occur before, concurrent with, or after visioning and goal-setting, depending on the needs of the watershed, available information, and capacity of the organization undertaking the tasks.

Step 2: Undertake a Watershed Monitoring Program

A long-term watershed monitoring program must be developed to continually assess performance against baseline characterization data and set targets. Generally defined as the periodic or continuous collection of measured parameters through the use of methods remaining consistent over time, long-term watershed monitoring involves a comprehensive approach to data collection, incorporating water quality with other watershed conditions indicators.

How Should Watershed Monitoring be Carried Out?

- Watershed monitoring requirements (e.g., a monitoring and reporting plan) should be developed during the watershed/subwatershed planning process, not afterwards;

- Watershed monitoring should measure changes against baseline conditions (e.g., before land development takes place or before restoration work occurs);
- Watershed monitoring should be timely. It should be carried out at the right times of year and at a frequency that reflects the response time for the component being measured;
- Watershed monitoring should be cost-effective. It should return significant information for the money invested;
- Watershed monitoring should yield useful information (e.g., it should provide answers to the questions that are being asked);
- Five years of pre-development monitoring is appropriate to achieve a baseline condition; and
- Watershed monitoring should be carried out on a coordinated, partnership basis, using data and information from various sources (e.g., municipalities, provincial and federal agencies, organizations, institutions and the public). The public should be involved in the development of the monitoring and reporting plan.

Monitoring the watershed (e.g., in activities such as monitoring amphibians and participating in bird census) helps to build stewardship.

As with the initial task of baseline characterization, continual watershed monitoring for water quality would include data on the physical, chemical, and/or biological conditions for all waterbodies within the watershed study area. Additionally, specific watershed characteristics including stream corridor traits, wetlands, and watershed land use/land cover patterns would also be collected and compared to baseline data as they relate to observed water quality.

Baseline Data, Conditions, and Indicators

The collection of baseline data is required to: capture an accurate "first look" at ecological characteristics and processes within the watershed, quantify various watershed specific parameters, and assist water practitioners in setting and implementing realistic and achievable future program targets. This data, collected at the outset of implementing a watershed management plan, can be sourced from a variety of places. For example, monitoring for water quality on a watershed basis would include the collection of physical, chemical and/or biological condition data as well as the recording of water quality characteristics specific to the watershed (e.g. stream corridor traits, wetlands, and watershed land use/land cover patterns). Canadian researchers and water practitioners are also able utilize baseline data from a variety of open databases, which are developed from national surveys of water and climate and maintained by the federal government. In many cases, data collected by provincial agencies are either maintained in-house or amalgamated with relevant federal databases, which in turn provide researchers with sufficient resources for completing baseline characterization and implementing any monitoring practices.

For more information on sources and collection methods of baseline data, please refer to **Section 8** of this document.

Data Typically Used for Watershed Characterization

Data Type	Typical Uses of Data
Physical and Natural Features	
Watershed boundaries	• Provide geographic boundaries for elevation and source control • Delineate drainage areas at desired scale
Hydrology	• Identify the locations of waterbodies • Identify the spatial relationship of waterbodies including what segments are connected and how water flows through the watershed (e.g., delineated drainage areas contributing to wetlands)
Topography	• Derive slops of stream segments and watershed areas (e.g., to identify unstable areas, to characterized segments and subwatersheds in watershed modeling) • Evaluate altitude changes (necessary when extrapolating precipitation from one area to another)
Soils	• Identify potential areas with higher erosion rates, poor drainage, or steep slopes • Use to delineate subwatersheds and develop input data for models
Climate	• Provide information about loading conditions when evaluated with instream data (e.g., elevated concentrations during storm evens and high flow) • Drive simulation of rainfall-runoff processes in watershed models
Habitat	• Describe area's ability to support aquatic life, and identify areas at risk of impairment • Support defining stressors that could be contributing to impairment • Identify shading or lack of riparian cover • Support identification of potential conservation, protection, or restoration areas • Identify any in-stream flow alterations of stream fragmentation
Wildlife	• Identify special wildlife species to be protected • Identify potential sources of bacteria and nutrients
Land Use and Population Characteristics	
Land use and	• Identify potential pollutant sources (e.g., land uses, pervious vs. impervious surfaces)

land cover	• Provide basis for evaluation of sources, loading, and controls • Provide unit for simulation in watershed models • Identify environmentally protected areas and other relevant land uses under provincial policy
Existing land management practices	• Identify current control practices and potential targets for future management • Identify potential watershed pollutants sources
Waterbody and Watershed Conditions	
Water quality standards	• Identify protected uses of the waterbody and associated water quality standards
305(b) report	• Identify the status of designated use support in watershed waterbodies • Identify potential causes and sources of impairment
303(d) list	• Identify known pollutant impairments in the watershed • Identify geographic extent of impaired waterbody segments • Identify potential causes and sources of impairment
Existing TMDL reports	• Provide information on watershed characteristics, waterbody conditions, sources, and pollutant loads (for specific waterbodies and pollutants)
Source Water Assessments	• Identify water supply areas to be protected • Identify potential sources of contamination to the water supply

In identifying information needs for watershed and subwatershed studies, a clear understanding is needed of the issues the plan will address, and the types of recommendations that might be forthcoming from the plan. The definitions and policy directions for watershed and subwatershed planning provided in the provincial plans will assist with scoping information needs inside the Greater Golden Horseshoe Area; the direction of the PPS regarding water resources will assist with scoping information needs outside of the Greater Golden Horseshoe area. Consideration of Great Lakes agreements and the Great Lakes Strategy will also inform information needs and information gathering.

There will be circumstances when the planning team has no option but to undertake technical studies or an environmental monitoring program to evaluate sensitive land use interactions with subwatershed ecosystem features and functions.

Some considerations for establishing information needs and developing environmental monitoring plans include the following:

- Focus on collecting information that will identify potential management opportunities and solutions, rather than just issues or problems;
- Determine whether any missing information is essential for preparing the watershed or subwatershed plan;
- Determine if information needs can be cross-referenced with existing or proposed watershed, subwatershed, and subdivision plans;
- Assess the possibility of better coordinating the gathering of information to improve the efforts of the watershed or subwatershed planning team; and
- Determine what information was important in successful plans, and learn about lessons in less successful efforts.

Watershed Indicators

During the early stages of indicator selection, there are a variety of factors that must be considered to ensure a holistic and broad approach to watershed characterization.

Some factors to consider when selecting watershed indicators include the following:

Validity

- Is the indicator related to your goals and objectives?
- Is the indicator appropriate in terms of geographic and temporal scales?

Clarity

- Is the indicator simple and direct?
- Do the stakeholders agree on what will be measured?
- Are the methodologies consistent over time?

Practicality

- Are adequate data available for immediate use?
- Are there any constraints on data collection?

Clear Direction

- Does the indicator have clear action implications depending on whether the change is good or bad?

When measured in the urban environment, water quality measurements capture the various pollutants from roads and private properties washed into the storm drain system, as well as the cross connections to sanitary sewer lines or leaky sanitary sewer lines infiltrating into storm drain systems. Pollutants associated with the above can include metals from vehicle wear and leakages (e.g. copper, zinc, cadmium and lead), fuels and other petroleum products. Elevated levels of nutrients (phosphorus and nitrogen) and sediment from construction activities and soil erosion are also commonly found in urban runoff. When untreated stormwater runoff is discharged directly to receiving waters, pollutant loadings can be much higher than those attributed to

domestic sewage and have been found to cause significant impacts to aquatic life in receiving waters. Stormwater runoff and pollutant discharges increase steadily with urbanization because of the increase in impervious surfaces, which reduces infiltration of rainfall and runoff.

Provincial Water Quality Objectives and the CCME Canadian Water Quality Guidelines

Ontario's Provincial Water Quality Objectives (PWQO) and the CCME Canadian Water Quality Guidelines (http://st-ts.ccme.ca/en/index.html) are useful references for water practitioners to consider when selecting indicators. These objectives include numerical and narrative criteria serving as physical indicators to represent satisfactory levels for both surface water features (i.e. lakes and rivers) and, when discharges to the surface, the ground water of the Province. The PWQOs are set at a level of water quality which is protective of all forms and aspects of aquatic life cycles during indefinite exposure to the water. Objectives associated with the protection of recreational water uses are based on public health and aesthetic considerations.

The PWQOs are also intended to provide guidance towards water quality management decisions, such as the designation of provincial surface waters to reduce further environmental degradation. These objectives are often used as a starting point to derive waste effluent requirements included in Certificates of Approval and other instruments issued to regulate effluent discharges. Additionally, they can also be utilized to assess ambient water quality conditions, infer use impairments, and assist in assessing spills and monitoring the effectiveness of remedial actions. Reference documents providing details on the development of each PWQO are available from the MOECC. Please note, the PWQO listing is routinely updated to reflect new or revised Objectives.

Where no PWQO or CWQG exist, other sources of guidelines (in order of preference) are the Federal Environmental Quality Guidelines and the British Columbia Water Quality Guidelines.

Where existing data is unavailable, field investigations can be used to fill data gaps. Field investigations can be focused to areas such as settlement areas and designated greenfield areas within broader subwatersheds, to manage the scope of activities. Ecological monitoring will be able to provide data for characterization, plan development, and adaptive management.

Sources of Available Baseline Data

Although physical monitoring of the watershed is necessary to understand specific baseline details of the area, a wide variety of public baseline data sets are also available for developers of Watershed Plans to utilize. In Canada (and Ontario), this data is collected and held by a variety of agencies. Please refer to the below for a list of available datasets that should be considered in advance of implementing a "boots on the ground" monitoring plan.

Environment and Climate Change Canada (ECCC) provides the following list of sources containing pre-existing baseline data which may be useful in undertaking watershed planning:

- Canadian researchers use **baseline data** from databases developed from **national surveys of water and climate** and maintained by the federal government. In many cases, data collected by provincial agencies are maintained by the provinces or contributed to the federal database, thereby providing research with a solid basis;
- **Water quantity and climate monitoring** are carried out across the country through national programs under the responsibility of ECCC;
- **Water quantity monitoring** is undertaken through ECCC's hydrometric program and carried out under formal agreements with the provinces and territories;
- For **water quality monitoring**, several federal-provincial/territorial agreement-based networks exist, and some provinces have their own networks in place; however, a more coordinated and comprehensive approach is needed. To that end, collective efforts are being made through the **Canadian Council of Ministers of the Environment (CCME)** to revitalize capacities and build a Canada-wide integrated network for water quality monitoring;
- **Groundwater Quality Monitoring** is undertaken through the Provincial Groundwater Monitoring Network (PGMN), which began in 2000 and is designed to monitor ambient groundwater level and chemistry conditions across Ontario. There are currently 474 wells in the PGMN program that monitor groundwater levels on an hourly basis. These wells are not used to supply water and are used for monitoring groundwater conditions only; and
- With respect to drinking water quality, Health Canada, provincial/territorial health departments, and their partners are monitoring waterborne disease under the **National Enteric Surveillance Program**. Health Canada and the provinces/territories also collaborate in the development of the Guidelines for Canadian Drinking Water Quality.

Over 300 **Canadian Environmental Quality Guidelines** have been developed collaboratively by jurisdictions, which are related to the protection of aquatic ecosystems, the quality of sediment and soil, and the assessment of contamination in aquatic life.

Connection to Watershed Planning Elements

Characterization of watersheds will provide a basis for setting goals, objectives, targets, and indicators, as discussed in **Section 5** of the Watershed Planning Guidance.

Characterization of watersheds will be linked to applicable watershed and subwatershed planning components outlined in **Section 6** of the Guidance (Watershed Planning Elements & Best Practices).

Monitoring and adaptive management considerations, as set out in **Section 8** of the Watershed Planning Guidance, should be considered early in the watershed planning process since these considerations will be ongoing.

5 Setting the Vision, Goals, Objectives, & Targets

What is it?

Essentially, the vision, goals, objectives and targets of a watershed plan set the parameters for the actions and land-use planning decisions made under that plan. It is essential that they align with applicable provincial policies, plans and reflect local conditions.

Why is it important?

Visioning will help to determine priorities, values, and issues in a given watershed. Setting early goals will help to guide and scope watershed planning processes. Goals and objectives will evolve through the planning process, as a result of information gained through watershed characterization.

How to do it?

Step 1: Determining a Vision and Developing Goals

Vision – is your aspirational statement of where you want to be in the future. Your vision sets the framework for your goals, objectives and targets.

> The Province's natural heritage resources, water resources, including the Great Lakes, agricultural resources, mineral resources, and cultural heritage and archaeological resources provide important environmental, economic and social benefits. The wise use and management of these resources over the long term is a key provincial interest.
>
> *— Excerpt from Part IV: Vision for Ontario's Land Use Planning System, Provincial Policy Statement, 2014.*

A vision should be realistic, credible and easy to understand. It is important to revisit the vision from time to time as your Watershed Plan is modified, or you have to adapt to changed realities.

Tips for developing a vision:

Use your steering committee to brainstorm words or short expressions of expectations for your applicable watershed:

- Pick a time period in the distant future; imagine your watershed at that time.
- Collect all the words or expressions, grouping them into themes.
- Based on themes, collectively agree to a vision statement.

Goals – are the outcomes you want to achieve. Goals tend to be broad expressions of values and aspirations. In the case of a watershed, your goals will relate to the aspirational outcomes anticipated for your watershed if you accomplish everything that will be set out in your objectives and targets.

There are several ecosystem planning principles to consider when developing goals for watershed planning, including:

- Ecosystem-based approach
- Precautionary approach
- Landscape-based analysis
- Adaptive management
- Sustainable development
- Collaboration

Watershed planning goals should address the various features, values, or threats to a watershed including; water quality, water quantity, aquatic species, flood protection, natural features, recreational values, etc.

Goals should be attainable, economically achievable, have stakeholder and political endorsement, and be flexible enough to accommodate shifting natural conditions.

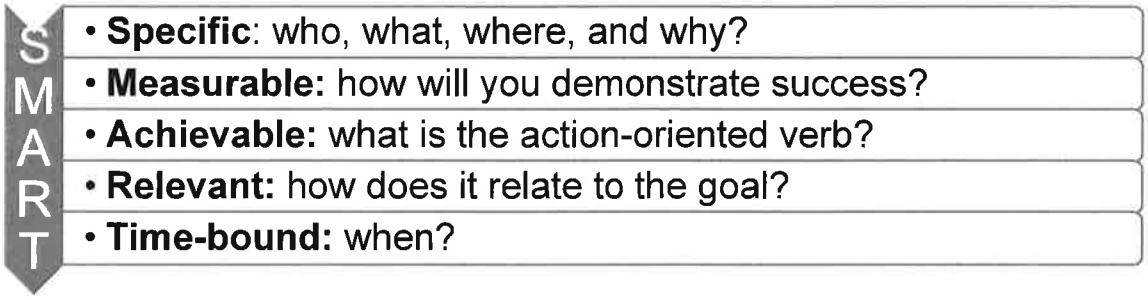
Tips for developing goals:

- Goals should be few in number, since each goal may have several objectives, and each objective may have numerous targets.
- Goals can be short-term or long-term. When developing your plan, consider what your short-term and long-term time horizons are, which will impact your goals, objectives and targets. For example, a short-term time horizon may be one to five years, while long-term is greater than five years. Goals should be articulated to provide measurable results based on chosen time horizons.
- After characterizing and delineating your watershed, you may have specific problems that you wish to address. Your goals could be specific to the issues arising from the watershed characterization and delineation.

Step 2: Developing Objectives and Targets

Goals, objectives and targets can be developed simultaneously as they branch out from each other in varying levels of specificity.

Objectives – are precise outcomes necessary to achieve your goals. They are detailed statements of qualitatively or quantitatively measurable results you hope to accomplish. They are more concrete and narrow than goals. Objectives should be **S.M.A.R.T**:



Tips for developing objectives:

- Similarly to goals, objectives can be short-term or long-term. Ensure the objective's time-horizon aligns with whatever time-horizon you chose for your goal. Since objectives are more specific and concrete than goals, you could have both short-term and long-term objectives under a single goal.
- Keep objectives to a manageable and realistic number under each objective.
- Use the S.M.A.R.T. acronym to help develop objectives.

Targets – allow you to set more specific time-based, percentage-based, or other quantitative measures to meet their particular objective. Targets allow you to measure progress towards the relevant objective.

There are different types of targets that could apply to watershed planning:

Process	• Measures a process, policy or activity • Example: Stream corridors are publicly owned and protected
Inputs	• Measures resources invested or used • Example: Invest $xx.xx over five-year period in streambank restoration activities
Outputs	• Measures the level of use or activity • Example: Maintain long-term stable water levels
Outcomes	• Measures the end results • Example: Greater than 75% of surface water samples meet the PWQO.

Municipalities undertaking watershed planning should keep the following tips in mind for developing targets.

Tips for developing targets:

- What kinds of data are you collecting or measuring that can help determine whether you have met your objectives?
- Ensure you can reliably collect the information necessary to determine whether you have reached the target.
- Targets for watershed planning can make use of existing provincial policies and guidelines for indicators like water quality parameters, water quantity metrics, and habitat percentage requirements.
- Targets can be developed that consider both spatial and temporal scales.

Step 3: Tying it All Together

Once you have developed your vision, goals, objectives and targets, determine whether they align. Ensure you have considered the financial and human resource implications of your expected results to make sure this is something you can accomplish.

Here is a hypothetical example:

Goal: A healthy aquatic ecosystem with sustainable biodiversity.

Objective: Protect or restore the health of wetland ecosystems.

Targets: Increase wetland cover to 15% of total watershed area (all watersheds).

***Remember:** There can be more than one objective under each goal, and more than one target under each objective. The above example is to illustrate the varying levels of specificity between goals, objectives and targets.

6 Watershed Planning Elements & Best Practices

Watershed planning elements include eight components outlined in the following sub-sections:

- Water budgets, water conservation plans, and surface and groundwater quantity considerations are outlined in **Section 6.1**.
- Water quality for surface and ground water, nutrient loading, and assimilative capacity assessments are outlined in **Section 6.2**.
- Natural hazards are outlined in **Section 6.3**.
- Climate change considerations are incorporated through the Watershed Planning Guidance, although more specific guidance is outlined in **Section 6.4**.
- Interconnections with natural heritage features, areas, and systems, as well as the benefits of green infrastructure, are outlined in **Section 6.5**.
- Consideration of cumulative impacts is outlined in **Section 6.6**.
- Analysis of land use and management scenarios is outlined in **Section 6.7**.

Not every component of watershed planning will be applicable to every watershed, so readers should consult the sections which address the needs of their local communities and watersheds.

6.1 WATER QUANTITY, WATER BUDGET, & WATER CONSERVATION PLANS

What is it?

Provincial policies with regard to water resources require that planning authorities protect, restore, or enhance the quality and quantity of water. This section of the Watershed Planning Guidance deals with water quantity considerations, and specifically water budgets and water conservation plan.

A **water budget** quantifies elements of the hydrologic cycle within a watershed or subwatershed study area at an appropriate level of detail. These elements include precipitation, interception, evapotranspiration, infiltration, storage and surface runoff amounts on an annual average basis. A water budget model can project the impacts of proposed land use or management changes on the water budget/water resource availability and to assess mitigation measures intended to maintain a given water

budget state. A water budget can be used to assess if water use is sustainable, if resources are stressed, or likely to become stressed.

Figure 3 illustrates elements of water budgets:

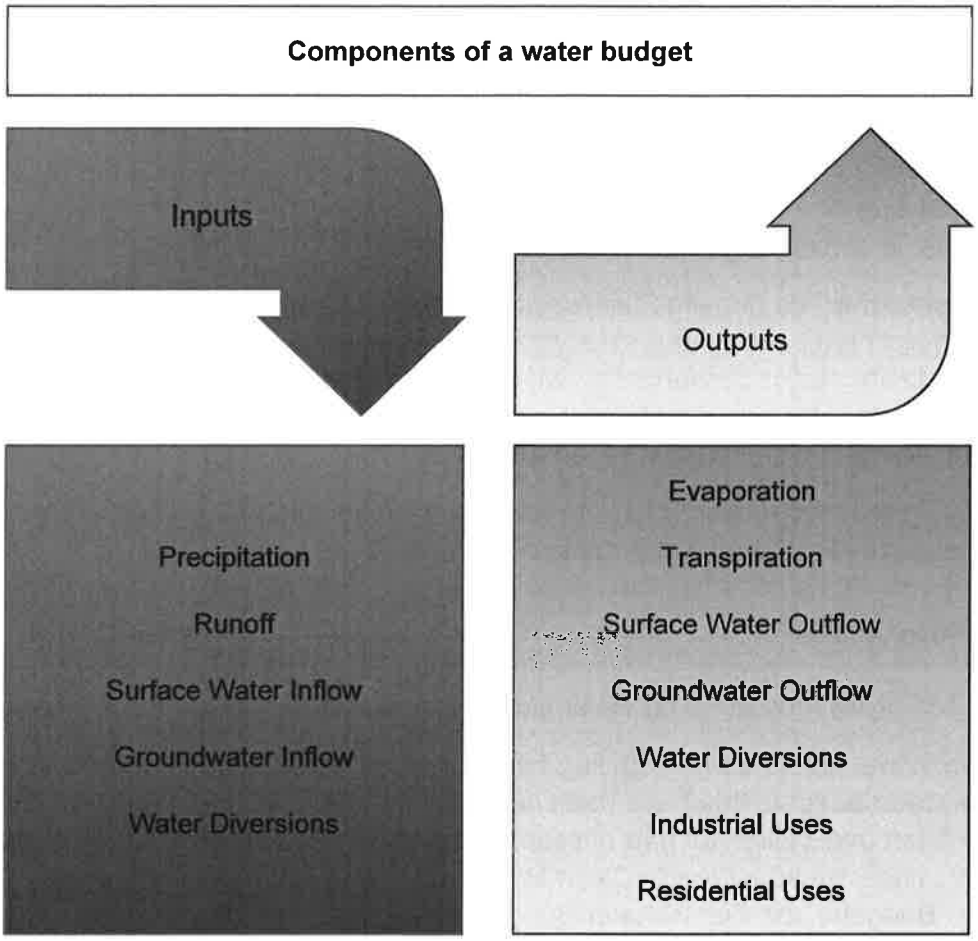


Figure 3 - Basic components of a water budget (draft)

More detailed water budgets might consider seasonal conditions, extremes based on historical data and projections that account for climate change impacts. Water budgets should include accounting for cumulative effects of existing and future conditions.

Changes in hydrology can impact the quantity and quality of water reaching natural features, public and private property habitat, water flows (flooding, drought), and erosion potential. Understanding how water moves within a water resource system is important to understanding the cumulative impacts of land use activities, such as development projects (proposed and existing).

Uses of a Water Budget

- to set water allocation targets and recharge rates within local watersheds;
- as a decision-making tool to evaluate land and water uses such as restoration and rehabilitation;
- projects identified in management plans;
- evaluate the cumulative effects of land and water uses within watersheds;
- to provide a watershed scale framework for site scale studies (e.g. evaluation of a sewage & water system plan);
- to help make informed decisions about the design of environmental monitoring programs; and
- to assist in setting targets for water conservation.

Water conservation The Growth Plan requires that municipalities will develop and implement official plan policies and other strategies in support of the conservation objectives, including water conservation, which can achieved through water demand management for the efficient use of water, and through water recycling to maximise reuse and recycling of water (Growth Plan 4.2.9.1.a).

In the ORMCP area, subsection 25(2) provides specific direction for the minimum contents of water budgets and water conservation plans.

Why is it important?

Legislation and policy incorporating water budget assessments include the following:

- ***Clean Water Act*** is a major driving force for the watershed and subwatershed scale water budgets that have been carried out in the province. Water budgets have been undertaken as part of source protection planning processes across the province, pursuant to the *Clean Water Act*. Conceptual Water Budgets, Tier 2 Water Budgets, and Tier 3 Water Budgets have been undertaken, depending on the characteristics and needs of the watershed.
- **The Water Budget and Water Quantity Risk Assessment Guidance Module** provide the basic direction to carry out the technical water budget characterization. These water budgets, once incorporated into a provincially approved assessment report will be used to set policies to manage water uses within local areas to protect sources of municipal drinking water. MNRF's Water Quantity Geodatabase project developed a water budget model in support of source protection planning. The Water Quantity Geodatabase will be useful for municipalities undertaking watershed planning in southern Ontario.
- **The Oak Ridges Moraine Conservation Plan** specifies that detailed water budgets and water conservation plans be carried out to support land use plans and development (ORMCP 25). Water budgets and water conservation plans were both required as part of watershed plans in ORMCP, and have been

supported by *ORMCP Technical Paper #10 – Water Budgets and #11 – Water Conservation Plans*. Also, where water budgets have been previously completed for watershed planning in ORMCP, these water budgets may need to be updated to reflect climate change considerations as outlined in MNRF's *Water Budget Reference Manual*.

- **The Provincial Policy Statement, 2014** states that the diversity and connectivity of natural heritage features in an area should be maintained, restored or, where possible, improved (2.1.2), and the quality and quantity shall be protected, improved or restored (2.2.1). Water budgets are encouraged to meet these requirements.
- **Provincial plans**, such as Growth Plan, Greenbelt Plan, and ORMCP identify water budgets and water conservation plans as some of the typical components of watershed planning.
- **The Lake Simcoe Protection Plan** has requirements for Tier 2 water budgets, where not already completed under the *Clean Water Act*, and water conservation plans for specific municipalities.

To a limited extent and without formal water budget guidance, the following provincial guidelines and manuals inherently promote the use of water budgets to meet their technical objectives:

- **Stormwater Management Planning and Design Module**;
- **Hydrogeological Technical Information Requirements for Land Development Applications**;
- **Guidelines for the Preparation of a Rural Servicing Report for Development to be Serviced by On-Site Sewage Systems**;
- **Permit to Take Water Manual**; and,
- **Official Plans** across Ontario mention water conservation, environmental protection and other things related to the protection and enhancement of ground and surface water quantity. **Water budgets** are a basic tool to fulfill the objectives and are commonly used in support of water supply and land use management.

How to do it?

Water Budget

In 2013, MNRF released its *Water Budget Reference Manual,* which provides direction for hydrology and water budget analysis, including climate change considerations with regard to water budgets. The *Water Budget Reference Manual* describes applications of water budgets, including: source water protection, watershed and subwatershed studies, permits to take water, aggregate extraction, and others. Municipalities should refer to this document when undertaking water budget analyses.

A water budget for a given area can be conceptualized as water inputs, outputs, and changes in storage. The inputs (precipitation, groundwater or surface water inflows, anthropogenic inputs) must be equal to the outputs (evapotranspiration, water supply removals or abstractions, surface or groundwater outflows) as well as any changes in storage within the area of interest.

The water budget process can encompass various levels of assessment, from simplistic to complex, depending on level of concern about how much water is available. The higher the tier, the more complex the science involved and the narrower the geographic focus. Water budgets need to consider this information on a variety of spatial and temporal scales.

Numerical models use simplified representations of these processes and enable quantification and evaluation of the hydrologic system at various levels – watershed, subwatershed and site scale. They may operate at different time steps and spatial resolutions and use a variety of approaches to represent key hydrologic processes.

Although these models can provide quantitative values, it is important to recognize the uncertainty in numerical modeling and use the models appropriately in making water management decisions. The most appropriate model for water budget analysis will depend on the type of questions that the model is required to answer.

Water budgets can be described according to the following generalized equation:

In the simplest form this can be expressed as:

Inputs = Outputs + Change in storage

$P + SW_{in} + GW_{in} + ANTH_{in} = ET + SW_{out} + GW_{out} + ANTH_{out} + \Delta S$

Where;

- P = precipitation;
- SW_{in} = surface water flow in;
- GW_{in} = groundwater flow in;
- $ANTH_{in}$ = anthropogenic or human inputs such as waste discharges;
- ET = evaporation and transpiration;
- SW_{out} = surface water flow out;
- GW_{out} = groundwater flow out;
- $ANTH_{out}$ = anthropogenic or human removals or abstractions; and
- ΔS = change in storage (surface water, soil moisture, groundwater).

Conceptually, there are three compartments to consider in the water budget determination as shown in the following figure: the ground surface; the unsaturated zone and the saturated zone:

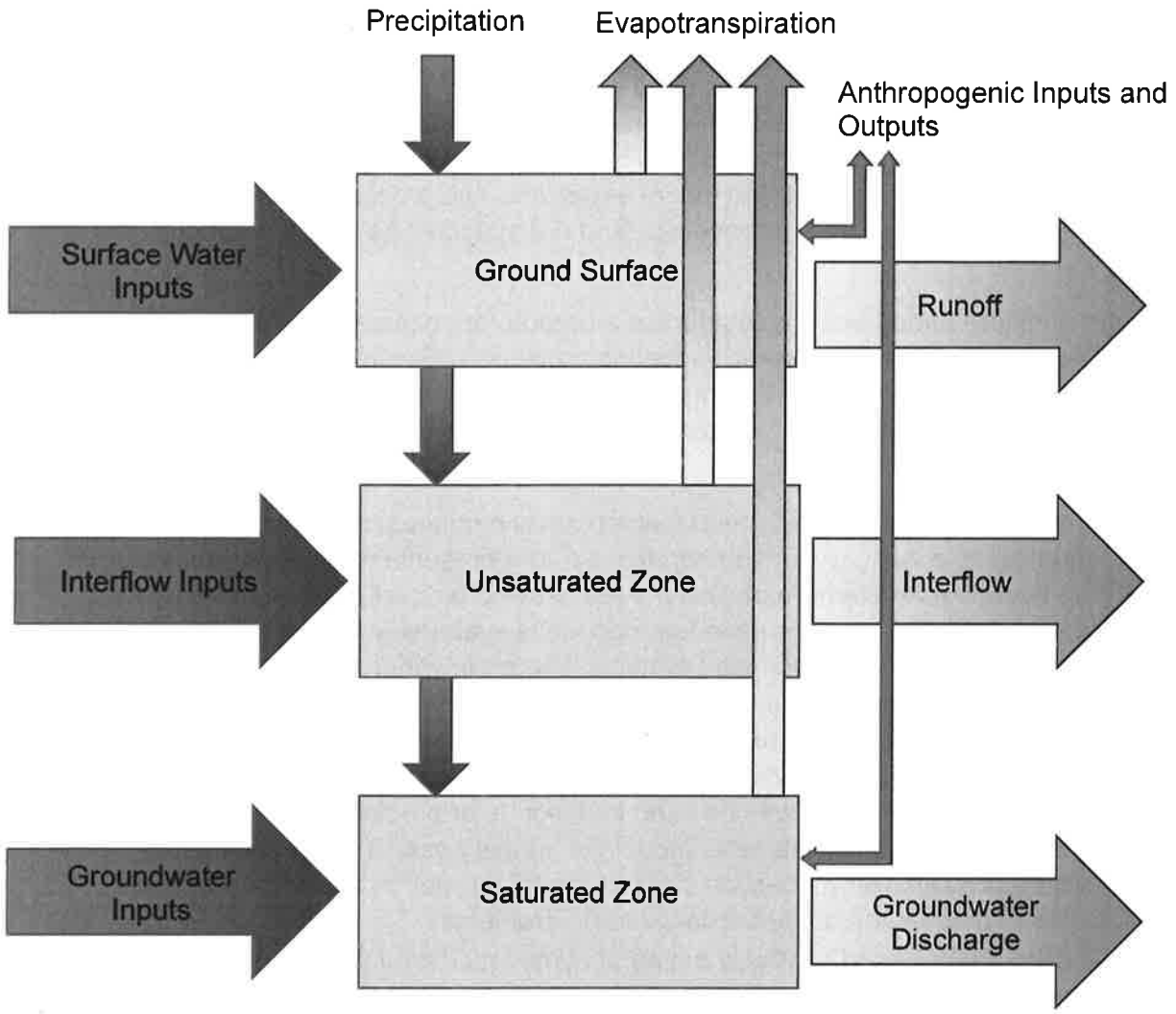


Figure 4 - The three conceptual storage zones in a water budget

The above figure shows that evapotranspiration can occur from any of the three (3) conceptual storages, as well as relevant anthropogenic inputs. Anthropogenic inputs and outputs of water involve some form of water transport across catchment or watershed divides. Human interventions are often difficult to account for in a water budget owing to the fact that a certain portion of the withdrawn water is likely re--circulated back within the same watershed (e.g. through lawn watering or through leakage from municipal infrastructure, etc.).

Water Budget Models and Types

The three basic types of numerical models that are built and used for water budget analysis are:

- Groundwater models;

- Surface water models; and
- Conjunctive or integrated continuum models.

Commonly, an integrated approach is used where output from both a surface water model and a groundwater flow model is iteratively compared. Traditionally, assumptions are made about all processes in a model. The processes of greatest interest are those that are explicitly represented in the model equations. The processes considered least important are treated as lumped processes and are specified as inputs or outputs to the model.

A range of different models exist to address a breadth of needs and requirements for local watershed planning and water budgeting processes. Essentially, models can be developed and used to account for, the fluxes through the various components of the hydrologic cycle. An overview of numerical models, lumped parameter models, and physically-based models follows:

- **A numerical model** is a type of mathematical model used to approximate a field situation by solving governing equations that represent the physical processes of the hydrologic system. Analytical models provide a direct solution of the governing equations for simple homogeneous systems, whereas numerical models simulate more complex systems where the various parameters can vary spatially and temporally and the governing equations are solved approximately.
- **A lumped parameter model** is a type of numerical model that solves the equations describing a system at a large scale by assuming that average values for physical parameters can be used to describe or predict the behaviour of a system. In a lumped parameter model the spatial position is not considered important to answer a question such as the total runoff in a watershed. These types of models are applied to large scale problems.
- **A physically based model** is a type of numerical model that solves equations where spatial position is an important consideration. Physically based model equations are derived from fundamental physical principles and/or extensive observations to describe the causes and effects of the system processes and their combined effects on the system behaviour. In these models, the actual rather than average (lumped) physical parameter value is important. Physically based models simulate small-scale to large-scale problems by incorporating spatial variability and interdependence of processes.

Selecting a Model

The most appropriate model for water budget analysis will depend on the dominant flow processes; whether it is dominated by surface water or groundwater. In most watersheds in Ontario, changes in groundwater discharge and storm event processes will affect the flow in the river such that linking of surface water – groundwater models, or the use of conjunctive models is most appropriate for water budget analysis. The effective application of a numerical model for water budget analysis requires:

- definition of specific objectives of the analysis at the start;
- identifying the characteristics of the hydrologic system through development of a conceptual model (review existing reports: size, spatial variations, land use variability, topography, geologic structure, etc.);
- determination of the "Scale of the Problem" or the level of detail that needs to be included (e.g. subwatershed versus site scale or forested versus open areas) depends on processes;
- determination of the appropriate time scale;
- collection or compilation of sufficient data to evaluate each process;
- suitability for linkage to GIS;
- ease of calibration and validation;
- recognition and minimization of the uncertainty in the analysis; and
- re-evaluation of the applicability of the analysis prior to addressing new objectives.

Secondary considerations include:

- available resources (e.g. for model application, training and maintenance, etc.); and
- model availability, preferably from an organization that provides regular updates and technical assistance.

Commonly Applied Models

A summary of models used in Ontario for water budgets is provided in Table 4-3 of MNRF's *Water Budget Reference Manual.* This table identifies the name, developer, and a brief description of common surface water, groundwater, and integrated groundwater-surface water models used in Ontario. The ORMCP Technical papers also serve as a valued source of information regarding models used for water budgets in Ontario. To account for climate change and severe weather considerations in water budgets, the *Water Budget Reference Manual* should be consulted. It provides potential hydrologic impacts due to climate change, and it outlines a guide to hydrological assessment incorporating climate change. The *Guide for Assessment of Hydrologic Effects of Climate Change in Ontario* can also assist with incorporating climate change considerations into watershed planning.

Water Conservation Plans

Watershed plans should also include water conservation plans which are important for Municipalities to undertake to maintain water resources. Recognizing water as a valuable and non-renewable resource which must be utilized efficiently and cost-effectively is necessary when looking to sustain related social, environmental, and economic drivers within the watershed study area. Water conservation systems can help in avoiding, downsizing, or postponing water and wastewater projects.

Key Steps for Water Conservation Plans

The ORMCP Technical Paper 11 – Water Conservation Plans also recommends that Water Conservation Plans include additional conservation goals, measures and incentives to ensure long-term success. These items include:

- Incorporate an ecosystem (holistic) and an adaptive environmental management approach;
- Illustrate anticipated effects of conservation measures on water demand and supply capacity (e.g. as a result of reducing leaks and losses);
- Develop an implementation plan for the water conservation plan, including any barriers that may affect its implementation;
- Develop a plan for public consultation;
- Develop a plan for monitoring and evaluating effectiveness of the plan; and
- Specify how results of plan implementation will be reported.

ORMCP Technical Paper 11 – Water Conservation Plans provides a useful framework to follow. The process outlined in this technical paper separates the development of a water conservation plan into three phases: defining conservation needs, choosing appropriate measures and incentives, and drafting the plan. Additionally, it is recommended that approval authorities, such as Conservation Authorities or other approval authorities in the same watershed, be included in the conservation planning process.

Defining Conservation Needs

- Develop Water Use Profile and Forecast
- Identify Water Conservation Goals - Link to Water Budget Analysis

Choosing the Appropriate Measures and Incentives

- Identify and Evaluate Water Conservation Measures
- Identify and Evaluate Water Conservation Incentives
- Analyze Relative Benefits and Costs of Measures and Incentives
- Select Conservation Measures and Incentives

Drafting the Plan

- Prepare Water Conservation Plan - plan should be a written account of the previous six steps, plus:
    - Illustration of anticipated effects of conservation measures and incentives on water demand and supply capacity;
    - An implementation plan; and
    - A plan for monitoring and evaluating effectiveness.

Revising the Plan

Review and re-evaluate the plan to ensure water conservation goals are being met.

For additional information on key steps associated with the above information, please refer to Section 5 of the *ORMCP Technical Paper 11 – Water Conservation Plans.*

Planning, Design, and Development Restrictions and Requirements

As previously noted, Water Conservation and Budgeting is a significant factor in the long-term health of a watershed study area. Supporting vital storage reservoirs and recharge zones for groundwater, which in turn feed wetlands, lakes, streams, and rivers, active conservation measures are crucial to ensuring sustainable demand from local residents as well as agricultural, industrial, commercial and recreational facilities. Inefficient water use practices, large drawing activities from surface and groundwater sources and climate change can also have long-term impacts on environmental, public health and local economies. As a result of the above, it is necessary for water practitioners to consider a variety of planning, design and development restrictions and requirements, based on best practice examples related to water, wastewater, and stormwater master planning to ensure efficiency and optimization of water use across the watershed.

Examples

1) Enhancing Stormwater Capture / Infiltration to Maintain Ecological Flows

With significant advances in watershed management over the past three (3) decades, water practitioners now must address a broad suite of technical issues including maintenance of hydrologic processes and the natural water balance, as well as the enhancement of fish habitat, stream morphology, and terrestrial habitats and the mitigation of the observed and forecasted impacts of climate change. Through the use of Green Infrastructure and Low Impact Development (LID) technologies, planners, engineers, landscape architects and designers have a variety of tools available to enhance Stormwater capture and infiltration to maintain ecological flows.

Draft LID Stormwater Management Guidance Manual (2017)

Ontario is developing new guidelines that could recommend stormwater flow attenuation through the use of LID to better maintain the natural hydrologic cycle.

Low Impact Development Stormwater Management Planning and Design Guide (2010.)

The intent of this guide is to act as a tool to help developers, consultants, municipalities and landowners understand and implement sustainable stormwater planning and practices in the Credit Valley Conservation (CVC) and Toronto and Region Conservation Authority (TRCA) watersheds. The use of sustainable stormwater planning and practices will help ensure the continued health of the streams, rivers, lakes, fisheries and terrestrial habitats in our watersheds.

Policy Example: Lake Simcoe Protection Plan.

Relevant policies, such as those presented in the LSPP (Recommendation 4-1) can include the promotion and support of low impact design (LID) solutions such as rainwater harvesting, rain gardens, and grey water reuse to manage stormwater and supplement residential water use.

2) Water Reclamation

While there are currently no provincial guidelines policies or regulations enacted by the Province for water reclamation and reuse, taking a proactive approach to increase efficiencies within these systems can result in significant savings for both water and power consumption.

Water and Energy Conservation Guidance Manual for Sewage Works (Chapter 4).

The intent of this manual is to inform sewage works owners, managers, process engineers and operators on measures that can be taken to reduce energy and water use at their facilities, and on options and considerations for water reclamation and reuse. Chapter 4 of this Guidance Document provides a comprehensive outline of various options for reusing or reclaiming water, including a helpful comparison of the level of treatment and economic, social and environmental factors for various water reuse options for water practitioners to consider.

6.2 WATER QUALITY & NUTRIENT LOAD ASSESSMENT

What is it?

Water quality and nutrient load assessment involves developing an understanding of nutrient and other pollutant concentrations and loading rates in lakes and rivers as well as groundwater.

Quality of water can be measured by indicators associated with hydrologic function, including: oxygen levels, suspended solids, temperature, bacteria, nutrients, and hazardous contaminants. Negative impacts on quality of water can be assessed through environmental studies, such as water quality impact assessments in accordance with provincial standards.

Nutrients such as phosphorus can contribute to negative impacts on quality of water as well as degradation of sensitive surface water features, sensitive groundwater features, and their related hydrologic functions. Phosphorus loading and phosphorus concentration targets should be considered in watershed planning. Nutrient loading assessments may consider a range of nutrients which may be contributing to issues in the watershed.

Human activities are impacting water quality, compromising conditions for aquatic life, recreation and other opportunities that rely on clean water. By assessing the sources and means by which nutrients and pollutants are getting into water, better planning and mitigation practices can be incorporated into watershed planning.

Why is it important?

Nutrients and other pollutants play an important role in watershed health. For example, Lake Erie and Lake Simcoe have experienced issues with excess phosphorus resulting in eutrophication, hypoxia, nuisance algae blooms, and other impacts. Other lakes and rivers are experiencing similar issues with increasing frequency.

Green Book and Blue Book

The Provincial Water Quality Objectives (PWQOs) are intended to ensure that surface water quality is satisfactory for aquatic life and recreation and that water uses requiring more stringent water quality are served on a site-specific basis. Ground water quality is to be preserved to protect the greatest number of uses.

MOECC's 'Green Book' provides guidance with regard to deriving effluent requirements and deriving receiving water based effluent requirements. MOECC's 'Blue Book' provides direction with regard to managing the quality and quantity of both surface and ground waters, and provides PWQO, which will be important to consider in assessment of land use planning and development decisions on a watershed basis.

GLWQA, COA, and Canada-Ontario Action Plan

The GLWQA and associated agreements and strategies (e.g. COA, Canada- Ontario Action Plan to Reduce Phosphorus Loadings in Lake Erie, etc.) point to phosphorus and algal blooms as a threat to the Great Lakes. Ontario has adopted a target of 40% phosphorus load reduction by 2025, and Ontario is also working with provincial, national, and binational partners to reduce nutrient-related impacts from both urban and rural watersheds.

Ontario's Great Lakes Strategy

Ontario's Great Lakes Strategy provides an overview of the binational phosphorus reduction target set through the most recent COA. Recommended phosphorus loading targets are also outlined in the Annex 4 Objectives and Targets Task Team's final report to the Nutrients Annex Subcommittee (Annex 4 Objectives and Targets Task Team, 2015).

Source Water Protection

Water sources are secured from a water quality perspective by the implementation of policies in respective Source Protection Plans to reduce the risk of contamination from activities, existing or future, that are deemed to be significant drinking water threats. These policies and plans direct municipal land use planning and prescribed provincial instruments, as well as establish a formal process to provide for risk management planning.

Municipalities are required to develop risk management plans for chloride and pathogens in identified vulnerable areas for Source Protection Planning. Municipalities should continue to proactively manage the use of chloride in the watershed by following ECCC's Code of Practice for the Environmental Management of Road Salt, participating in programs like "Smart about Salt' and promoting salt and water efficient water softeners.

How to do it?

Step 1. Assemble and Map Monitoring Data

- Include watercourses and water bodies;
- Include drainage areas and landmarks such as roads and communities;
- Show land use classifications, point sources and other likely contributors to water quality conditions;
- Determine appropriate indices of water quality – chemical and biologic monitoring data;
- Compute indicator values from monitoring data; and
- Map indicators and identify spatial trends.

Mapping of indicators provides an invaluable means of communicating information that can be difficult to convey in any other way. Because water quality has such a geographic aspect to it, where there is a progression of flow from headwaters to downstream, understanding how conditions change from reach to reach is critical to understanding where impairments are and what influences are involved.

Indicators are an effective means of summarizing, quantifying and comparing relative states. Indicators of water quality include biologic data such as benthic and fisheries

surveys, concentrations of chemical constituents, and field measurements of parameters such as pH, dissolved oxygen, temperature, turbidity and conductivity. More physical indicators such as buffering of water courses, forest and canopy cover and stream bank stability may also be used to characterize influences on water quality conditions. Indicators might be used to track changes over time or indicate spatial distribution or patterns. Some indicators might be used as proxies for other important criteria that lack data to quantify directly.

Indicators form the basis of a target setting approach as they can be used to define the past, present, target and alternative scenario states.

Step 2. Identify Trends in Time

- Are there changes in water quality over time that suggest response to human activities?
- Are there gaps in the data that prevent adequate assessment of conditions?

Examining data for trends and gaps begins to tell the story of what is happening in the watershed over time. There are numerous ways of analyzing and viewing data sets to try to identify trends.

Step 3. Consider the Influence of Flow Regime

- Use hydrologic models, stream gauging and statistical approaches to characterize flow regime upstream and downstream of points of interest;
- Low flow conditions may limit dilution potential from existing or proposed point sources; and
- High flow conditions may exhibit high concentration of nutrients and pollutants from rural and urban runoff during storm and snow melt events.

Water quality and quantity are often related. Higher flows resulting from storm events and snow melt runoff often carry higher concentrations of sediment, nutrients and other pollutants. Pollutant concentrations tend to spike shortly after a significant runoff event begins as accumulated material on streets and other hard surfaces washes off into storm sewers and water courses. Higher flow volumes exhibit higher speeds with greater scour potential to erode stream banks, fields and construction sites.

Pollutant loading can be estimated using regression techniques with long-term continuous monitored stream flows and less frequent water quality grab samples that are distributed across high and low flow conditions. It is, however, highly dependent on availability of adequate data.

Water quality is often highly influenced by flow. High runoff might dilute point source loads, but increased concentrations may result from runoff. Low flows have less dilution potential but may exhibit higher quality because they may be comprised of higher proportions of groundwater. Load analysis provides a more consistent assessment.

Step 4. Assess Capacity of Receiving Waters to Assimilate Point and Non-Point Source Loads

- Point source discharge cannot be acutely toxic to aquatic life;
- Water quality downstream of point and non-point sources of nutrients and pollutants should achieve PWQOs under appropriate design conditions;
- Where PWOQs are already exceeded, any new development or discharges should not further impair water quality;
- Where PWQOs are currently achieved, any new development or discharges should not cause impairment of water quality above PWQO's;
- The mixed concentration in the receiving waters can be assessed by adding the ambient load with the waste load and dividing by the combined flow; and
- Consider other water quality goals and targets and objectives that have been agreed to by watershed management stakeholders and partners. For example, if there is a goal to improve fisheries habitat, consider factors that influence dissolved oxygen, temperature and other factors contributing to habitat viability. Determine how existing and proposed human activities influence these factors and develop planning that addresses them.

Step 5. Plan for Minimal Impact

- Consider where there is assimilative capacity in the watershed and where limits have been reached both at the point of interest and looking further downstream, using a cumulative effect approach;
- Address Provincial effluent discharge requirements;
- Require the adoption of technologies that address point and non-point source contributions to water quality conditions such as low impact development features, wastewater treatment systems and agricultural best management practices; and
- Apply modeling decision support approaches were appropriate to evaluate complex contributions from multiple sources.

Point Source

The 'Green Book' provides guidance for point source discharge to receiving waters. Policies are provided for areas with conditions that are better than objectives, and those areas not meeting objectives. Implementation procedures for effluent requirements, especially guidance for establishing effluent requirements, will be valuable for consideration through municipal watershed planning processes. Requirements include:

- In areas which have water quality better than the PWQO's, water quality shall be maintained at or above the Objectives;

- Water quality which presently does not meet the PWQO's shall not be degraded further and all practical measures shall be taken to upgrade the water quality to the Objectives;
- Prevent the release, in any concentration, of hazardous substances that have been banned;
- Ensure that special measures are taken on a case by case basis to minimize the release of hazardous substances that have not been banned; and
- Mixing zones should be as small as possible and not interfere with beneficial uses. Mixing zones are not to be used as an alternative to reasonable and practical treatment.

General procedures for establishing effluent requirements are outlined as follows:

General Procedures for Establishing Effluent Requirements

In establishing effluent requirements for discharges to surface waters, the procedures outlined below should be followed:

1) Site-specific receiving water assessments will be conducted to assess existing conditions and determine effluent requirements based on the waste assimilative capacity of the receiver. To make an assessment historical upstream water quality concentrations are assessed using the 75th percentile concentration.

2) The site-specific effluent requirement, so derived, will be compared, where applicable, to appropriate federal or provincial regulations or guidelines for effluent discharges and the most stringent requirement will be applied.

3) The effluent requirement derived from the above procedures, expressed as waste loadings and/or concentrations, will be incorporated into a Certificate of Approval or other control document.

4) For existing discharges in areas where water quality is degraded and does not meet the PWQOs, the Ministry may develop a pollution control program with each discharger to meet the effluent requirement determined from the above procedures.

Through the incorporation of water quality based limits into legally enforceable control documents such as a Certificate of Approval, the policies for water quality management become enforceable. These limits most commonly are for municipal or industrial point sources, but may also be applied to cooling water, stormwater or other polluting sources.

Rural Nonpoint Source

Non-point source pollution reduction strategies should aim to improve soil health and reduce soil and nutrient loss from rural lands. These strategies need to aim to reduce

nutrient and sediment loss and protect surface and groundwater. Non-point source pollution reduction should use a range of site appropriate management practices. Those practices eligible to receive stewardship funding should be increased over time as new technologies become available. Assistance should be directed to priority areas and monitoring and load reduction quantification procedures should be used to determine effectiveness of best management practices.

Nitrogen application to the land in areas of high groundwater recharge should be optimized to maintain productivity while minimizing environmental losses in priority subwatersheds.

There are many best management practices (BMPs) that can be implemented in a rural setting to help improve water quality and quantity:

- manure storage and management;
- private septic system repair or replacement;
- construction of bypass channels or bottom draws for online ponds;
- streambank erosion control and stabilization;
- cover cropping;
- tree and shrub planting;
- installation of cropland erosion control structures;
- clean water diversion;
- livestock access restriction and watercourse exclusion fencing;
- completion of nutrient management plans;
- crop residue management;
- strip cropping/contour farming;
- crop rotation;
- cover crops;
- hay/pasture;
- nutrient management;
- vegetated buffer strips along watercourses; and
- best practices for municipal drain design and maintenance.

Measures that are intended to address pollutants from non-point sources are inherently more difficult to quantify benefits from. As a result, many programs that promote non-point source management practices tend to be process based; meaning they measure success based on the number of projects implemented. A better means would be the adoption of more outcome based programming where funding and resources and provided per kilogram of load reduction. This approach is also consistent with the growing realization of a need for monetary valuation of ecological goods and services.

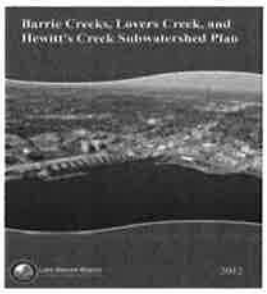
Urban Nonpoint Source

Municipalities should implement urban best practices that:

- Provide sustainable funding to support appropriate stormwater management programs;
- Develop and implement stormwater management master planning;
- Require proper sediment and erosion control measures be implemented for developing sites and ensure that requirements are enforced;
- Develop and deliver enhanced communication and education programs;
- Identify opportunities to retrofit existing uncontrolled areas;
- Allocate long-term funding for regular maintenance and operations of SWM facilities; and
- Reduce urban runoff at the source.

Where there are multiple complex point and non-point stresses on water quality, a modeling approach may be appropriate. Watershed modeling provides a means of evaluating how water quality conditions and pollutant loads might respond under different management or land use scenarios. It allows users to assess how land use and infrastructure changes could influence conditions both locally and further downstream as part of a cumulative effects assessment approach. Watershed modeling of water quality usually requires more complex models that consider hydrologic and shallow groundwater processes as well as sources and processes for water quality parameters of interest. Point and non-point sources are considered together with mixed land use types. More simplified approaches exist such as application of land use based export coefficients to estimate nutrient loads from a subject site for pre- and post-development conditions.

Example: Assessing Scenarios for Phosphorus Loading



An example of the assessment of land use and management scenarios with respect to nutrient loading can be found in the *Barrie Creeks, Lovers Creek, and Hewitt's Creek Subwatershed Plan*.

In the development of the subwatershed plan, consideration of phosphorus loading and assimilative capacity was necessary. The scenario analysis considered current land uses and sources of phosphorus, and then modeled phosphorus under: the current conditions, the approved growth scenario, and the approved growth scenario with implementation of agricultural BMPs. Urban BMPs were not modelled. The subwatershed plan provides the following commentary and process for phosphorus load estimates:

Surface Water – Phosphorus

Phosphorus occurs naturally in the environment and is a vital nutrient needed by both plants and animals. However, current land uses have increased the phosphorus loading to Lake Simcoe from an estimated 32 T/yr (prior to settlement and land clearing in the 1800s) to a current estimated 72 T/yr. Rural and agricultural land uses make up 5%, 36%, and 54% of the Barrie Creeks, Lovers Creek, and Hewitt's Creek subwatersheds, respectively. Runoff from pastures and crop land, as well as wind, which erodes topsoil, contributes to the phosphorus loading in mostly the Lovers Creek and Hewitt's Creek subwatersheds. Urban land use on the other hand use makes up 63%, 21%, and 18% of the Barrie Creeks, Lovers Creek, and Hewitt's Creek subwatersheds, and a considerable contribution to the phosphorus loading (particularly in Barrie Creeks) through stormwater runoff (discussed further in Section 3.3.2.9 [of the subwatershed plan]).

Phosphorus load estimates were originally calculated in the Assimilative Capacity Studies (ACS), 2006, but have since been updated by the original authors, the Louis Berger Group, in a report completed in September, 2010, entitled 'Estimation of the Phosphorus Loadings to Lake Simcoe'. A watershed model that estimates nutrient loads based on inputs such as land use, precipitation, and soil type was used for both the ACS and the updated study. The following tables (Table 3-7 to Table 3-9) present the average yearly phosphorus loads derived from each source in the subwatersheds under current conditions, the approved growth scenario, and the approved growth scenario with implementation of agricultural BMPs. Urban BMPs are not considered in this particular study as the model used did not consider them, but the model is currently being updated and future versions of this Plan will include the amount of phosphorus that can be reduced through urban BMPs, which are particularly important in the highly urbanized subwatersheds, such as Barrie Creeks. However, in Section 3.3.2.9 (Uncontrolled stormwater and impervious surfaces) [of the subwatershed plan], BMPs related to retrofit opportunities for stormwater ponds and the resulting phosphorus reduction is presented for each subwatershed.

The primary source of phosphorus in the Barrie Creeks subwatershed under existing conditions is derived from high intensity development land uses (58%) and point sources (38%). Under the approved growth scenario, there is a projected increase in total phosphorus loads of 6.5% without the implementation of agricultural BMPs (does not consider urban BMPs). The projected phosphorus load under the approved growth scenario can be reduced by 0% through the implementation of agricultural BMPs (Table 3-7). Under existing conditions, the Barrie Creeks subwatershed is the highest contributor of total phosphorus to Lake Simcoe (Figure 3-9). Under the committed growth scenario it is expected to be third highest contributor of total phosphorus, as the growth and development expected in both the East and West Holland subwatersheds puts them as the top two contributors to the lake (Figure 3-10) (Berger, 2010a).

6.3 NATURAL HAZARDS IN WATERSHED PLANNING & SUBWATERSHED PLANS

What is it?

Natural hazards, such as flooding hazards and erosion hazards, affect all regions of Ontario. On the Great Lakes shoreline, dynamic beaches are also considered as hazards. *Understanding Natural Hazards* provides introductory information on the Great Lakes-St. Lawrence River System and large inland lakes, as well as river and stream systems hazardous sites. Municipalities have a role in identifying areas subject to natural hazards, managing exposure to public health and safety risks, and directing development outside of hazardous lands and sites.

Regarding natural hazards, some key terms defined in the PPS include hazardous lands and hazardous sites. Hazardous lands are unsafe for development due to naturally occurring processes. Hazardous lands have different features in the Great Lakes-St. Lawrence River System, along the shorelines of large inland lakes, and along river, stream, and small inland lake systems. Hazardous sites are unsafe for development due to naturally occurring hazards, which could include unstable soils or unstable bedrock. From a watershed planning perspective, municipalities need to ensure that PPS policies and provincial plan policies are addressed, such as climate change considerations.

Why is it important?

PPS policies understand that Ontario's long-term prosperity, environmental health, and social well-being depend on reducing the potential for public cost or risk to Ontario's residents from natural or human made hazards. Directing development away from areas of natural or human-made hazards where there is unacceptable risk to public health and safety or to property damage, and not creating or aggravating existing hazards, are fundamental approaches of the PPS. The policies generally direct development outside of particular hazardous lands, such as adjacent to rivers, streams and small inland lake systems impacted by flooding and/or erosion hazards (PPS 3.1.1), and also restrict development and site alteration in defined hazards areas, such as the dynamic beach hazard and a floodway (PPS 3.1.2). Other hazards, such as ice storms, tornadoes, and droughts, are dealt with by MNRF.

Municipalities are delegated the responsibility of identifying areas subject to natural hazards, and developing management plans to limit exposure to public health and safety risks. This includes identifying hazard lands in municipal plans and incorporating policies to address new development consistent with PPS policies. Municipalities are

also responsible for the identification of hazard lands and adoption of land use mechanisms to prevent risks from inappropriate or unsafe development of these lands. Where they exist, conservation authorities have been delegated a commenting responsibility for the Natural Hazards policies. Depending on the nature of a proposal for development or land use change, approvals or work permits may be required by other agencies.

Understanding natural hazards is an important and necessary consideration in watershed planning. Flooding and erosion are naturally occurring processes influenced by local watershed conditions. Addressing these local physical processes and understanding their watershed scale affects is important from a watershed planning perspective. By understanding the function and susceptibility of various river, stream, and lake systems to disturbance, the potential impacts of proposed developments or remedial measures can be identified, and methods of reducing these impacts through design changes or mitigative measures can be implemented. This can involve inclusion of measures to enhance the overall health of the watershed in relation to mitigating risks due to natural hazards. Watershed planning plays an important role in defining, understanding, and managing these linkages and measures.

The location and extent of natural hazards can be outlined through such actions as floodplain mapping to identify regulatory flood lines, or for instance through soil and slope stability analyses to identify erosion and erosion potential. These considerations are important for informing where development may and may not occur, as well as for managing its associated impacts on natural watercourses, specifically regarding flooding and erosion — including where and how to focus mitigative measures.

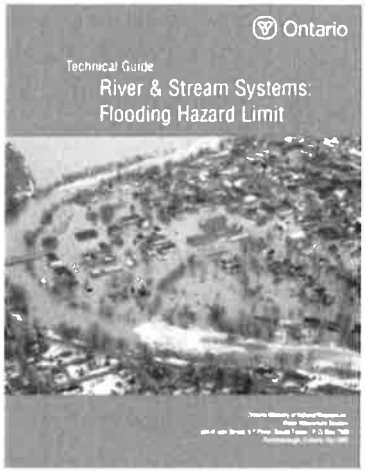
When information does not exist concerning the location of defined hazardous lands, or when existing information is identified as being out of date, municipalities and other planning authorities are advised to undertake studies to identify potential risks from natural hazards.

How to do it?

The sections provided below include a brief overview of how to address natural hazards in watershed planning.

Defining flood hazards limits, preparing flood plain maps and developing appropriate land use planning policies is the MNRF's preferred and most effective approach to hazard mitigation and management in Ontario.

Technical Guide – River and Stream Systems: Flooding Hazard Limit



The Province sets minimum standards to ensure that flood risks and costs to society resulting from riverine and lake flooding are reduced. The *Technical Guide - River & Stream Systems: Flooding Hazard Limit* (2002) provides the standards for defining flood hazards and describes the hydrologic and hydraulic work involved in defining flood hazards.

It is up to the municipality to determine how to best to identify floodplains in municipal plans and incorporate policies to address new development consistent with the PPS policy; the use of floodplain mapping is one tool available to demonstrate hazard areas. Municipalities may choose to rely on the services of conservation authorities to undertake floodplain mapping, where conservation authorities exist, but are not required to do so.

Seven general steps are outlined in *the Technical Guide - River & Stream Systems: Flooding Hazard Limit* and are intended to provide assistance to technical staff in the selection of procedures and implementation methods for floodplain studies, including the following:

Floodplain Study Tasks

Step 1. Select flood plain standard

- Identify study area to determine Zone* (*Refer to Figure B-1 Flood Hazard Criteria Zones of Ontario) and corresponding flood standard; and,
- Select flood standard from: Historical Storm (Hazel, Timmins), 100 year flood, or a historical storm observed in the area provided it exceeds the 100 year flood.

Step 2. Review data requirements, methods of hydrologic and hydraulic calculations

- Data requirement: streamflows, water levels, meteorological and physiographic data;
- Flood magnitudes: flood frequency analysis for 100 year floods, or hydrologic modelling of flood from a specified meteorological event;
- Hydraulic modelling, type of flow, cross-section data, roughness, bridge and culvert losses, plotting; and
- Select mapping.

Step 3. Select hydrologic modelling parameters

- Select rainfall input to modelling of flood standard: Hazel, Timmins, 100 year storm depth, duration, distribution, snowmelt;
- Select soil data; and
- Select land use.

Step 4. Select methods of computing flows

- Hydrologic models: single and continuous models;
- Computational procedures: snowmelts, infiltration, soil moisture account, base flow, watershed routing;
- Recommended model selection; and
- Model calibration.

Step 5. Select method of computing water levels for open water conditions

- Recommended models;
- Flood routing;
- Reservoir routing;
- Effect of lakes and reservoirs;
- Waterway crossings and encroachments; and
- Model calibration and sensitivity.

Step 6. Compute ice jam levels, where appropriate

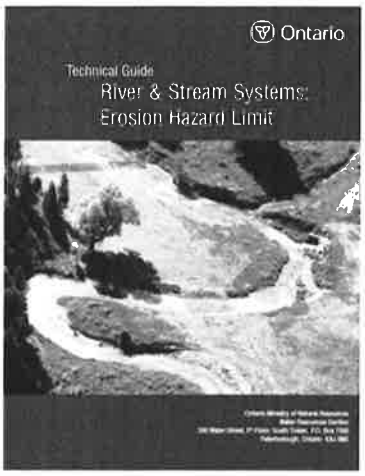
- Determine the need to compute ice jam levels for the site;
- Select ice jam computational method; and
- Estimate frequency of ice jams.

Step 7. Prepare technical report.

Hydrologic calculations to be completed to inform flood plain hazard analyses should include methods to evaluate and estimate flood flows through the use of models to simulate flow conditions. Hydraulic calculations are completed using a model that can determine corresponding water surface elevations and the flood profile through the use of backwater analyses. The resulting water surface elevations are mapped to produce floodplain maps.

For detailed technical information regarding the steps outlined above and associated methodologies and procedures, refer to the *Technical Guide – River & Stream Systems: Flooding Hazard Limit*.

Technical Guide – River and Stream Systems: Erosion Hazard Limit



River and stream systems are continuously changing in configuration and form as a result of natural processes such as erosion, transport, and deposition of sediment under varying hydrologic and hydraulic conditions. Land use change and watershed alterations affecting the hydrologic cycle have the potential to accelerate impacts. The interactions amongst the physical, biological, and human induced processes and their inter-relationships should be understood, assessed, and integrated as part of any implementation strategy or option aimed at sound planning and integrated management of watershed ecosystems and hazard lands.

The primary purpose of the *Erosion Hazard Limit Technical Guide* is to provide a consistent and standardized procedure for the identification and management of riverine erosion hazards in Ontario. The Guide is based on a standard and relatively simplistic methodology that is intended to be applied to two generalized landform systems through which river and stream systems flow; specifically, confined streams and unconfined systems. The Guide serves to assist technical staff experienced in natural hazard management to select the most appropriate methods and flexible implementation measures in the identification of riverine erosion lands.

Specific information highlighted in the document includes direction on classifying river and stream systems into two simplified basic types, including confined or unconfined river and stream systems. For confined systems, a toe erosion allowance, allowance for stable slope, and erosion access allowance are identified. For unconfined systems, an allowance for the flooding hazard limit or a meander belt allowance is identified, in addition to an erosion access allowance. The Guide also provides guidance regarding describing the study and site and field investigation information, as well as direction on how to address the hazards in a watershed context, and an introduction to environmentally sound hazard management approaches.

Increasing pressure to develop along river and stream systems requires sound planning and management within the erosion hazard. The Guide documents a valuable procedure to aid decision makers in evaluating areas, or a particular location, to ensure that particular consideration is given to both the physical and ecological influences and impacts when selecting which if any natural hazard response would provide the best management practice given local site conditions. This includes:

Addressing the Erosion Hazard

Step 1. Identify the Hazards

Step 2. Identify Development Proposed Within the Hazardous Lands or Hazardous Sites

Step 3. Identify Appropriate Hazard Management Response

Step 4. Determine Potential Impacts to Physical Processes and Characteristics

Step 5. Assess Off-Site Physical Impacts

Step 6. Assess Biological or Environmental Impacts

Step 7. Mitigate Minor Impacts of Preferred Hazard Management Response

For additional details, refer to the *Technical Guide – River and Stream Systems: Erosion Hazard Limit* document.

If your municipality borders a Great Lake or large inland lake, or has occurrences of unstable soils (sensitive marine clays, organic soils) or unstable bedrock (karst bedrock) classified as hazardous sites, please refer to the following applicable Technical Guides, pertinent to those situations:

- MNRF, 2001. Technical Guide for Great Lakes St. Lawrence River Shorelines, Flooding, Erosion and Dynamic Beaches.
- MNRF, 1996. Technical Guide for Large Inland Lakes, Flooding, Erosion and Dynamic Beaches.
- MNRF, 1996. Technical Guide for Hazardous Sites.

Climate Change: Risks for Infrastructure and Land Use Planning

Infrastructure is particularly vulnerable to increased risk from natural hazards, such as flooding and erosion, and it is anticipated that climate change will increase this risk.

PPS policies for Natural Hazards provide that planning authorities shall consider the potential impacts of climate change that may increase the risk associated with natural hazards (PPS 3.1.3). For infrastructure and land use planning, this could involve: re-visiting flood mapping during the development review and approval process, ensuring that climate change considerations are incorporated, and ensuring that land use planning is integrated with municipal asset management planning.

Consideration of infrastructure vulnerability and adaptation in the land use planning process should take into account, for example: whether there is infrastructure in areas that may become prone to flooding, whether flooding or drought will impact existing and planned servicing, and whether existing grey infrastructure can be augmented by green infrastructure. Provincial policies require water, wastewater, and stormwater management planning to be informed by watershed planning, or to demonstrate a

proposed development's compliance with applicable watershed plan or subwatershed plan criteria. As such, watershed planning can look ahead towards ways it can inform watershed-wide infrastructure strategies to promote resilience, rather than reacting to site-by-site development needs.

Information Sources

- MNRF Natural Hazards Technical Guides:
  - MNRF. 2001. Understanding Natural Hazards.
  - MNRF. 2002. Technical Guide – River & Stream Systems: Flooding Hazard Limit.
  - MNRF. 2002. Technical Guide – River & Stream Systems: Erosion Hazard Limit.
  - MNRF. 2001. Technical Guide for Great Lakes-St. Lawrence River Shorelines, Flooding, Erosion and Dynamic Beaches.
  - MNRF. 1996. Technical Guide for Large Inland Lakes, Flooding, Erosion and Dynamic Beaches.
  - MNRF. 1996. Technical Guide for Hazardous Sites.
- MNRF. 1998. Geotechnical Principles for Stable Slope
- Existing municipal data, mapping and programs
- Conservation authority data, mapping, and programs
- Existing official plans, zoning by-laws, plans of subdivision and condominium

6.4 CLIMATE CHANGE & WATERSHED MANAGEMENT

What is it?

As atmospheric levels of greenhouse gases (GHG) increase, stresses are placed on natural landforms and hydrologic systems in the form of increased natural hazards and extreme weather events. Variations in weather and precipitation patterns, lake levels, and stream flow regimes are anticipated as a result of a changing climate, which may result in negative impacts on hydrologic features and functions. Such stresses are exaggerated when anthropogenic influences and development pressures reduce the physical areas available to allow natural systems to perform functions that maintain components of the hydrologic cycle.

While the theoretical impacts of such stresses have been extensively researched and modelled, the consequences of future negative potential impacts associated with climate change are still growing areas of expertise. Climate change presents both challenges and opportunities for communities in Ontario. Scientific research and practical experience with regard to mitigation, adaptation, and resilience has highlighted the need for increased capacity to plan and adapt to less predictable environmental conditions and risks.

Why is it important?

Watershed planning can provide an ecological framework for managing impacts of climate change and developing more resilient communities, since it is an ecosystem-based, integrative approach to protection of water for both communities and the environment. Integration of watershed planning with natural hazard management will also assist with reducing risks associated with climate change impacts and severe weather events. Ontario's Climate Change Strategy and Action Plan recognise the role of watershed planning in addressing climate change.

Mitigation of greenhouse gas emissions and adaptation to a changing climate is a matter of provincial interest under section 2 of the *Planning Act*. Section 6 of the *Planning Act* requires that official plans contain policies that identify goals, objectives, and actions to mitigate GHG emissions and to provide for adaptation to a changing climate, including through increasing resiliency. Watershed planning provides a framework for development of such goals, which can be included in official plans to implement provincial policy directions.

Watershed planning, as defined in the Growth Plan and the Greenbelt Plan, typically includes consideration of climate change impacts and severe weather events, and scenario modelling to evaluate forecasted growth and servicing options, among other components.

Natural features and green infrastructure provide ecological services which can mitigate impacts of climate change, and such features are typically cheaper to protect and manage compared to the lifecycle costs of traditional grey infrastructure approaches. Many natural systems are inherently well positioned to attenuate the effects of extreme conditions if they are not already compromised or stressed. Increased canopy cover and greater amounts of green space can reduce the impact of urban heat island effect by measurable amounts, reducing cooling needs. Natural wetlands also reduce flood peaks and retain nutrients and other pollutants. Provincial policy support for green infrastructure and low impact development demonstrates the importance of natural heritage systems and water resource systems in mitigating and adapting to climate change.

The concern for the potential impacts of climate change, as well as the need for early assessment and mitigation planning, have been considered in recent provincial documents and existing frameworks. Applicable policies for the reduction of greenhouse gases and emissions, and for reduction of the future risk of climate change-related hazards, are identified within the PPS. In brief, these policies:

- Encourage the use of green infrastructure and require stronger stormwater management practices during development (PPS 1.6.2, 1.6.6.7);

- Mandate that energy conservation, including improved energy efficiency, reduced emissions of GHG, and adaptation to climate change be considered (PPS 1.8); and
- Require that the increased risks of the potential effects of climate change, primarily those associated with natural hazards be considered during development (PPS 3.1.3).
  ***Note:** This is generalized wording of these policies.*

The PPS policies above were considered during the development of the draft Guidance for the Consideration of Climate Change in Environmental Assessment in Ontario, as some class environmental assessments have requirements under the *Planning Act.* Together these PPS policies require planning and infrastructure proposals to identify a wider range of factors to improve the ability of such projects to respond and resist hazards imposed by the potential impacts of climate change. Additionally, infrastructure required for flood control and migration, such as dams and dykes, are typically subject to Class EA processes, so alignment between watershed planning/subwatershed plan processes should be considered in order to streamline future approvals and development.

How to do it?

Currently, there is no common list of best practices for climate adaptation, since climate change and its impacts vary from one location to another, and communities vary in their exposure and capacity to cope. Visions, risk tolerance, capacities, and other factors vary from community to community, so even those facing similar risks and opportunities may make different adaptation choices on a watershed basis.

Organizations such as ICLEI Canada have been working to assist municipalities and other planning authorities with climate change mitigation and adaptation. ICLEI has a range of useful resources and programs for municipalities to consult in undertaking climate adaptation projects. Also, organizations such as Federation of Canadian Municipalities have provided support to communities seeking to plan for and adapt to impacts of climate change. Information sources provided in this section should be consulted to gain insight into potential impacts of climate change, and potential mitigation/adaptation strategies.

The following steps provide considerations and tools for addressing climate change on a watershed basis:

Step 1: Consider the Potential Effects of Climate Change on Existing and Proposed Land Uses, Infrastructure, and Developments

The following are considered potential effects of climate change within a watershed/subwatershed boundary, and should be considered by municipalities in watershed planning, management, and infrastructure planning:

Drought

Trends indicate increased precipitation in winter, decreased precipitation in summer, increased evapotranspiration rates, reduced snow accumulation and earlier snow melt.

Extended Periods of Extreme Heat and Cold

Extreme temperature conditions are expected as a result of climate change, putting pressure on our energy supplies through our increased dependence on heating and cooling systems.

Flooding

Climate change is expected to result in more intense and frequent precipitation events. Increased infrastructure and impervious surface area coverage will increase runoff, as well as the potential for severe flooding and erosion. Greater amounts of precipitation in the winter could see higher amounts of snow accumulation in some years followed by rapid melt with the potential to increase flood risk especially when coupled with the possibility of more intense spring rainfall events. The decline in natural systems such as wetlands, that are inherently good moderators of runoff, leaves settlement areas more susceptible.

Changes to Water Supply

Less water may be available for residential, agricultural, industrial, power generation and transportation due to changes in seasonal changes in precipitation, as well as an increased frequency of use. Decreased availability of water supply will impact ecosystems, including biodiversity, shoreline, and wetland stability.

Water Quality

Warmer air temperature and reduced summer stream flows could result in impacts to cold water fisheries. Current initiatives to store and infiltrate more urban stormwater will provide some ability to counteract effects of heated urban runoff. Rising water temperatures have implications for increased growth of algae, lower dissolved oxygen concentrations, higher concentrations of unionized ammonia and higher E-coli concentrations. Reduced flows can reduce the dilution potential and assimilative capacity of water courses that receive treated wastewater.

For water, wastewater, and stormwater servicing and infrastructure, the increasing uncertainty and unpredictability of events such as droughts and floods will make it more

difficult to provide for an integrated, coordinated approach to land use and infrastructure planning. For example, where a municipality depends on groundwater for municipal drinking water in a quantity-stressed area, it will be difficult for the municipality to determine if a proposed development can be sustainably serviced or how it will impact downstream developments.

Municipalities should ensure that visioning/goal-setting as part of watershed planning successfully incorporates considerations for risks and vulnerabilities associated with climate change, as listed above.

Step 2: Consider the Effects of Existing and Proposed Land Uses and Water/ Wastewater/ Stormwater Management Infrastructure on Exacerbating Climate Change Impacts

Municipalities should assess how current water uses and existing infrastructure could negatively impact the watershed by exaggerating climate change effects. Such impacts imposed by changes in land use, new developments, and planning could include:

- Decreasing pervious surface areas (paving);
- Removing vegetation and habitats;
- Increasing or decreasing water takings from local sources; and
- Increasing or decreasing water temperature.

In the assessment, water uses and existing infrastructure should be evaluated to determine:

- **The volume of GHG emissions produced;**
- **Contributions to carbon storage and sequestration;**
    - Consider indirect and direct sources of greenhouse gases; and
    - Changes in local hydrology over time due to predicted future land uses and topography (through development, changes in vegetation coverage, etc.).
- **The incorporation of mitigation features in past and current project planning within these land uses and infrastructure;**
    - impact management measures.
- **The presence of alternative land use methods that consider the potential effects of climate change more effectively; and**
    - Operational changes to reduce the overall carbon footprint of land uses (time of year when operations are less laborious, less vegetation is destroyed, etc.); and
    - Make use of industry standards, best management practises, most efficient technology.
- **If potential effects of climate change arising from current land uses have the potential to impact First Nations communities in the future.**

- Regular engagement to ensure potential effects of climate change imposed by current land uses are transparent and known. Incorporate traditional knowledge from these communities into municipal planning to identify areas of concern requiring protection.

Step 3: Determine Impacts of Alternative Land Use and Management Scenarios Under Various Climate Models

There are numerous global climate models being developed and used around the world to better understand the impacts of climate change. Each model has its own boundary conditions and means of representing complex processes. Over time, these models are enhanced by accessing more computing power and increasing scientific understanding of the many sources and sinks and dynamic processes of GHGs and feedback loops.

Although many of the available models show agreement on the direction of climate trends, they often differ in their estimates of the magnitude of change that can be expected. Communicating the results of these predictions is also complex because of the variance between models, the spatial and temporal resolutions they use and the lengthy periods of time they are trying to characterize. Running climate change models necessitates the use of scenarios that make assumptions regarding the future rate of release of GHGs. The most recent findings suggest future trends will be punctuated with numerous seeming exceptions. An average of 3 degree C warmer winters might include numerous instances of record breaking cold within the same period.

Climate change mitigation and adaption are important parts of protecting and restoring a watershed. For example, historical climate data may no longer be relevant to setting performance standards for stormwater management facilities. As part of the Climate Change Action Plan, the province is working to enhance climate data for stormwater infrastructure decision-making, by updating future projected rainfall IDF curves (intensity-duration-frequency curve graphs) for the 2030s, 2050s, and 2080s in local Ontario communities, which are available through the Ontario Climate Change Portal.

Information from climate change models tends to predict long term trends relative to a historic baseline condition. They are able to estimate relative changes to temperature and precipitation and suggest adjustment factors for intensity-duration-frequency curves. In order for these projections to be meaningful in watershed management and inform planning, design and identification of potential development restrictions, these projections need to be used as inputs to other tools used to model watershed response. Bridge designs need to account for higher flow volumes and velocities with greater potential to undermine structures and river banks. Similarly, low flow and drought conditions characterized by a future climate should be part of the design of water intakes and effluent discharge systems to ensure adequate volumes under drought conditions. Water conservation should be built into watershed and subwatershed planning to lessen the effects of water shortage. For more information on Water Conservation, please refer to **Section 6.1** of the Watershed Planning Guidance.

A common approach used to address uncertainty in individual climate change models is to apply an ensemble approach where multiple models are applied and the results are used together to better understand the range of potential impacts or changes that might be expected. This adds to the complexity of modeling watershed processes because now there are multiple simulated watershed responses to consider that must be compared against baseline or historic conditions when making design decisions. Since climate change models are attempting to characterize conditions over long periods of time, a frequency of exceedance type approach might be used where an acceptable threshold is identified and results from the multiple scenario models are used together to assess the probable frequency that a threshold might be exceeded.

As recommended in the draft Consideration of Climate Change in Environmental Assessment in Ontario (2016) guide, historical and present climate data, as well as modelled projections should be consulted to evaluate the broad effects of climate change on long-term water management within the watershed, including:

- The vulnerability of current water management strategies, land uses, existing infrastructure, and surrounding ecosystems to the potential impacts of climate change;
- Assess if current water use, storage, and management could cause future impacts to the natural environment if negative climate change impacts do occur;
- Evaluate if modelled consumption and management trajectories will impact water or lands associated with First Nation communities; and
- Assess the availability of technology, infrastructure, or methods that could withstand the potential impacts of climate change more efficiently.

All components regarding water use and management within the watershed/subwatershed should be evaluated against all estimated severities, and frequencies of weather events. Results from completing these queries will identify areas within existing frameworks that are most sensitive to the potential effects of climate change. Buffers and mitigation should be developed to assist management frameworks in becoming more resilient.

Examples of queries designed to assess the capacity of existing management frameworks against the potential effects of climate change are as follows:

- At what volume could a surge in precipitation and runoff exceed the capacity of existing wastewater management infrastructure?
- Will current water use be sustainable if the driest estimated drought conditions are reached?
- Will present structures used to contain and store stormwater withstand future predicted storm events?

Mitigation plans and objectives resulting from the above queries may include developing infrastructure or management plans that can withstand a wider range of potential natural hazards and conditions impacting water supply and water quality, such as:

- Develop water conservation and/or drought management plans;
- Reduce demand through conservation measures or more efficient water use;
- Expand the storage capacity of existing water supplies;
- Develop new water supplies or retention structures;
- Change design capacity of drainage infrastructure such as storm sewers, catch basins, and erosion protection structures; and
- Manage rainwater on-site to ease demands on drainage infrastructure.

Step 4: Document Climate Effects on Water Use and Management within the Watershed or Subwatershed Plan

Within existing water management plans, long-term measures should be taken to document the potential effects of climate change, as well as to identify the efficacy of qualitative and quantitative information identified in previous steps recommended by the draft Consideration of Climate Change in Environmental Assessment in Ontario (2016) guidance document.

Documentation should consider all components of the watershed/subwatershed system, such as changes in hydrology, water supply and quality, natural land forms, the occurrence of natural hazards, as well as water use. Data for this documentation should include:

- Historical data and baseline conditions,
- Data collected from conservation and/or drought management plans,
- Data collected from water quality monitoring programs,
- Annual and seasonal patterns for temperature and precipitation,
- Freeze/thaw cycles of water bodies, and
- Changes in flood plain mapping (contours, location, and extent of flood plain boundaries).

To maintain the resiliency of watershed management plans over time, documented data as well as ongoing scientific research within the watershed should be evaluated to re-assess mitigation strategies through adaptive management. More information regarding adaptive management can be reviewed in **Section 8** of this Guidance Document.

Information Sources

Other relevant resources to inform watershed planning in setting out potential future conditions include the following:

- MOECC, 2016. Draft Guidance for Consideration of Climate Change in Environmental Assessment in Ontario

- CCME, 2015. Implementation Framework for Climate Change Adaptation Planning at a Watershed Scale
- MOECC, 2016. Climate Change Strategy
- MOECC, 2017. Climate Change Action Plan
- MOECC, 2017. Lake Simcoe Climate Change Adaptation Strategy
- Ontario Climate Change Data Portal

6.5 CONNECTIONS TO NATURAL SYSTEMS

What is it?

Natural Heritage Systems are made up of natural heritage features and areas (core areas), linked by corridors (linkages), to maintain biological and geological diversity, natural functions, and viable populations of native species and ecosystems.

Watersheds, subwatersheds, and groundwater resources, including the network of tributaries that support major river systems are critical to long term health and sustainability of water resources, biodiversity, and ecological integrity.

Watershed planning provides a logical ecological basis for consideration of interconnected natural and hydrologic features and functions.

Why is it important?

A coordinated, integrated, comprehensive approach to NHS planning has been implemented province-wide, as directed by PPS policies and the provincial plans, and supported by resources such as the NHRM, HMHE? and the *ORMCP Technical Paper Series*.

Since natural heritage features and water should be considered together because they are inherently linked natural systems, emphasizing the importance of consideration on a watershed basis.

Watershed planning at the upper-tier and single-tier municipal levels should be integrated with the province's regional NHS approach.

Growth Plan policies require municipalities to incorporate provincially identified NHS, outside of settlement areas and the Greenbelt Plan, and to apply appropriate policies to maintain, restore or improve its diversity and connectivity. Greenbelt Plan policies for the Protected Countryside area provide that official plans will contain policies and mapping regarding: the boundaries of the Greenbelt area, Protected Countryside, NHS, agricultural land base, key natural heritage features, key hydrologic areas, associated minimum vegetation protection zones, and wellhead protection areas.

In addition to identification and protection of the key hydrologic areas through watershed planning, a number of indicators should be considered from a subwatershed perspective. Specifically, natural cover, wetland cover, woodland cover, and hardened/impervious surfaces should be considered on a subwatershed basis, in alignment with ORMCP requirements for permitting major development in subwatersheds and provincial performance indicators for subwatersheds. In the Performance Indicators for the Growth Plan, these features were considered as indicators to assess performance in relation to minimum guidelines for watershed coverage outlined by ECCC:

- 10% or less hardened/impermeable surfaces for newly urbanizing watersheds;
- 10% or more wetland cover; and
- 30% or more forest cover.

How to do it?

Step 1: Determine Existing Natural Heritage System on a Watershed Basis

Refer to existing mapping and official plan policies for natural heritage systems, water resource systems, key hydrologic features and areas, the results of watershed characterization including identification of the water resource systems, and other studies or evaluations.

Determine interconnected features, areas, and functions across watersheds and jurisdictions, to support protection of quality and quantity of water and to support watershed ecological objectives. GIS mapping and analysis can provide insight into connectivity and gaps.

Watershed characterization undertaken as part of watershed planning should provide relevant information to identify and protect features and linkages between natural heritage systems and water resource systems. At the subwatershed level, information regarding impervious surfaces and natural cover (including wetland cover and woodland cover) should be documented, and targets should be identified in accordance with provincial and national guidelines.

Step 2: Determine Additional Information Required (If Needed), and Map Interconnected Natural Systems and Water Resource Systems

Ensure that there is adequate data and information to identify and map core features, linkages/corridors, natural features, water features, and potential areas for protection/restoration/enhancement. Criteria for identification of core and linkage areas are provided in *Development of the Regional Natural Heritage System for the Growth Plan for the Greater Golden Horseshoe*, building on the NHRM and HMHE?.

Step 3: Consider Adequate Goals, Objectives, Targets, Criteria, and Indicators for Protection of Natural Systems on a Watershed Basis

Ensure that watershed delineation and characterization provide for protection of natural heritage features and areas. Also ensure that watershed characterization takes into account existing and proposed natural heritage systems, and the location of existing and proposed land use changes and development. Setting the vision, objectives, goals, and targets for the watershed or subwatershed will require consideration of provincial and national guidelines, as well as local watershed conditions.

Targets for restoration and protection of riparian areas are often a part of watershed planning. Maximizing extent of riparian vegetation can contribute to watershed ecological objectives, and provide habitat and ecosystem services.

HMHE? provides resources in section 2.2 (Riparian and Watershed Habitat Guidelines) which are relevant to watershed planning. HMHE? describes riparian areas as areas containing vegetation communities and soils with attributes of both wetland and upland areas, which also provides the transition between forest and stream, hillside and valley, as well as terrestrial and aquatic ecosystems. Targets and rationale are outlined, and the document should be consulted by municipalities and others undertaking watershed planning. The targets outlined in HMHE? could form the basis for developing goals and targets in local watershed plans and subwatershed plans.

Information Sources

A range of resources and tools exist to assist with identifying and protecting natural heritage features, areas, and functions. Background resources also outline context and rationale for protection, and link to other strategies across scales and jurisdictions.

Additional relevant information sources for natural heritage include:

- MNRF, 2010. Natural Heritage Reference Manual.
- ECCC, 2013. How Much Habitat is Enough?
- Significant Wildlife Habitat Technical Guide (and associated Ecozone Guides).
- ORMCP Technical Papers.
- MNRF mapping products and Make a Map.
- Ontario's Biodiversity Strategy.
- Ontario's Wetland Conservation Strategy.
- Ontario Protected Area Planning Manual 2014.
- SOLRIS.
- MNRF data layer for landscape level inventory of natural, rural and urban lands in southern Ontario.
- Development of Regional Natural Heritage System for the Growth Plan for the Greater Golden Horseshoe – Summary of Criteria and Methods (MNRF, 2017) & Development of the Regional Natural Heritage System for the Growth Plan for

the Greater Golden Horseshoe – Technical Report on Criteria, Rationale and Methods (MNRF, 2017).
- Conservation Authority mapping, and existing plans and studies.
- Municipal official plan mapping, zoning mapping, plans of subdivision/condominium, site plans, and draft-approved development documentation (i.e. background studies).

ECCC Habitat Guidelines

Summary of Wetland, Riparian, Forest, and Grassland Habitat Guidelines	
Wetlands	
Percent wetlands in the watershed and subwatersheds	Ensure no net loss of wetland area, and focus on maintaining and restoring wetland functions at a watershed and subwatershed scale based on historic reference conditions. At a minimum, the greater of (a) 10% of each major watershed and 6% of each subwatershed, or (b) 40% of the historic watershed wetland coverage, should be protected and restored.
Wetland location in the watershed	Wetlands can provide benefits anywhere in a watershed, but particular wetland functions can be achieved by rehabilitating wetlands in key locations, such as headwater areas (for groundwater discharge and recharge), floodplains and coastal wetlands. Consideration should also be given to protecting networks of isolated wetlands in both urban and rural settings.
Amount of natural vegetation adjacent to the wetland	Critical Function Zones should be established around wetlands based on knowledge of species present and their use of habitat types. Protection Zones should protect the wetland attributes from stressors. Recommended widths should consider sensitivities of the wetland and the species that depend upon it, as well as local environmental conditions (e.g., slopes, soils and drainage), vegetative structure of the Protection Zone, and nature of the changes in adjacent land uses. Stressors need to be identified and mitigated through Protection Zone design.
Wetland proximity	Wetlands that are in close proximity to each other, based on their functions, or that are in close proximity to other natural features, should be given a high priority in terms of landscape planning.
Wetland area, shape and	Capture the full range of wetland types, areas and hydroperiods that occurred historically within the watershed. Swamps and marshes of

diversity	sufficient size to support habitat heterogeneity are particularly important, as are extensive swamps with minimum edge and maximum interior habitat to support area-sensitive species.
Wetland restoration	Focus on restoring marshes and swamps. Restore fens under certain conditions. For effective restoration, consider local site conditions, have local sources to propagate new vegetation, and wherever possible refer to historic wetland locations or conditions. Prioritize headwater areas, floodplains and coastal wetlands as restoration locations.
Riparian	
Width of natural vegetation adjacent to stream	Both sides of streams should have a minimum 30-metre-wide naturally vegetated riparian area to provide and protect aquatic habitat. The provision of highly functional wildlife habitat may require total vegetated riparian widths greater than 30 metres.
Percent of stream length naturally vegetated	75% of stream length should be naturally vegetated.
Percent of an urbanizing watershed that is impervious	Urbanizing watersheds should maintain less than 10% impervious land cover in order to preserve the abundance and biodiversity of aquatic species. Significant impairment in stream water quality and quantity is highly likely above 10% impervious land cover and can often begin before this threshold is reached. In urban systems that are already degraded, a second threshold is likely reached at the 25 to 30% level.
Forest	
Percent forest cover	30% forest cover at the watershed scale is the minimum forest cover threshold. This equates to a high-risk approach that may only support less than one half of the potential species richness, and marginally healthy aquatic systems; 40% forest cover at the watershed scale equates to a medium-risk approach that is is likely to support more than one half of the potential species richness, and moderately healthy aquatic systems; 50% forest cover or more at the watershed scale equates to a low-risk approach that is likely to support most of the potential species,

	and healthy aquatic systems.
Area of largest forest patch	A watershed or other land unit should have at least one, and preferably several, 200-hectare forest patches (measured as forest area that is more than 100 metres from an edge).
Forest shape	To be of maximum use to species such as forest breeding birds that are intolerant of edge habitat, forest patches should be circular or square in shape.
Percent of watershed that is forest cover 100 m from forest edge	The proportion of the watershed that is forest cover and 100 metres or further from the forest edge should be greater than 10%.
Proximity to other forested patches	To be of maximum use to species such as forest birds and other wildlife that require large areas of forest habitat, forest patches should be within two kilometres of one another or other supporting habitat features. "Big Woods" areas, representing concentrations of smaller forest patches as well as larger forest patches, should be a cornerstone of protection and enhancement within each watershed or land unit.
Fragmented landscapes and the role of corridors	Connectivity width will vary depending on the objectives of the project and the attributes of the forest nodes that will be connected. Corridors designed to facilitate species movement should be a minimum of 50 to 100 metres in width. Corridors designed to accommodate breeding habitat for specialist species need to meet the habitat requirements of those target species and account for the effects of the intervening lands (the matrix).
Forest quality – species composition and age structure	Watershed forest cover should be representative of the full diversity of naturally occurring forest communities found within the ecoregion. This should include components of mature and old growth forest.
Grasslands	
Where to protect and restore	Focus on restoring and creating grassland habitat in existing and potential grassland landscapes.
Habitat type	Maintain, restore and create native grassland patches to their historic extent and type at a county, municipal and/or watershed

and area	scale considering past presence and current conditions.
Landscape configuration, heterogeneity and connectivity	Grassland habitat patches should be clustered or aggregated, and any intervening land cover should be open or semi-open in order to be permeable to species movement.
Patch size	Maintain and create small and large grassland patches in existing and potential local grassland landscapes, with an average grassland patch area of greater than or equal to 50 hectares and at least one 100-hectare patch.
Landscape heterogeneity	Some grassland habitat should be located adjacent to hedgerows, riparian and wetland habitats for species that require different habitat types in close proximity.

6.6 CUMULATIVE EFFECTS ASSESSMENT

What is it?

Cumulative environmental effects are accumulating changes in the environment caused by the combined effects of developments, land use changes, permits, licences, climate change, and infrastructure over time.

Watersheds provide a foundation for cumulative effects assessment, since the boundaries provide a logical ecological unit and geographic scale for consideration of environmental, social, and economic impacts of land use changes and development applications.

Cumulative effects assessment (CEA) is the process or method of assessing how much the environment has changed up until today, as well as what we think might occur in the future due to development as well as stressors such as climate change. Change in the environment is assessed relative to thresholds and targets to identify areas of higher impact and risk.

Cumulative effects management (CEM) is the process of using CEA information to inform decision-making, including watershed planning.

Development decisions are approved by government and regulatory agencies on a project by project basis (e.g., check marks in the figure). Each project on its own may not cause environmental effects but cumulative effects may occur when each project is considered in combination with other past, present and future projects.

Why is it important?

CEA tracks changes in environmental indicators over time and space and relative to targets, objectives, or thresholds. It considers natural variation in the assessments of the accumulated environmental condition as well as stressors such as forest fires and climate change. In the watershed planning context, this can be focused to particular risks of concern to the municipality or its stakeholders as identified in the watershed plan. CEA also tracks changes in development activities over time and space and relative to targets, objectives, or thresholds. The main outcome of the CEA is to identify areas and indicators of concern and options for mitigation and management. From a watershed planning perspective, CEA addresses assessment of cumulative, cross-jurisdictional, and cross-watershed impacts, which could be due to single, multiple, or successive development/site alteration activities.

PPS policies direct planning authorities to use the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering **cumulative impacts** of development and considering cross-jurisdictional and cross-watershed impacts. Similarly, Growth Plan and Greenbelt Plan definitions for watershed planning describe it as being a framework for establishing objectives and direction for management of resources as well as for the assessment of **cumulative, cross-jurisdictional and cross-watershed impacts**. The Ministry of the Environment and Climate Change Permit to Take Water program takes cumulative effects into account when decisions are made on permitted water takings. The program follows a set of six principles, of which cumulative effects is Principle 4: The Ministry will consider the cumulative impacts of water takings.

Cumulative impacts and downstream impacts beyond a single development site or planning application need to be considered as part of a comprehensive approach to management of human activities, land, water, aquatic life, and resources within a watershed. This is also important for informing growth and servicing allocations and determining actions to minimize negative impacts on quality and quantity of water and hydrologic functions.

A key purpose of watershed planning is to establish what the current watershed "condition is", where areas of concern and opportunity are and what the risks may be to the watershed given different development trajectories. If planning is successful, stakeholders in the watershed understand the watershed condition now, what it was in the past, what it may look like into the future, what the risks might be, and how those risks will be mitigated and managed. CEA is fundamental to watershed protection and watershed planning. In fact, watershed planning is driven by solid and defensible CEA.

The credibility of a watershed plan is dependent upon its approach to CEA. Many believe that CEA is an overwhelming and unrealistic task to complete. This however, is based on an assumption that CEA involves monitoring and assessment of everything,

everywhere all of the time. CEA can be directed, focused and adaptively managed to key indicators and risks within a watershed.

How to do it?

The key steps to a watershed CEA are illustrated in the following figure. Assessment of the existing state quantifies how key environmental and stressor indicators have changed over time until today to identify indicators and areas of higher risk. This information is very valuable to inform stakeholders in the watershed of areas of concern for mitigation and management. This information then feeds into predictive models that examine what the future predicted environmental state might look like under different watershed planning development scenarios and considering important stressors such as climate change. As the environmental conditions continue to be measured over time, one can determine if predictions of the models were accurate and where adaptive management is required. Both of these phases of CEA require decision support tools to implement; one to assess and report on existing accumulated state and one to build from this state to model different scenarios into the future to support watershed planning and risk mitigation for stakeholders. Municipalities and watershed planners should keep in mind that CEA can be focused to a scope and scale specific to areas, indicators, timeframes and stressors within the watershed or sub-watershed undergoing planning.

The way this Watershed Planning Guidance is structured might suggest CEA is something independent of the other sections of this guidance document. In fact, CEA is the integrator of all of it. Individual disciplines involved in planning are brought together through CEA to construct a plan and to then measure progress along a trajectory towards the planning outcome.

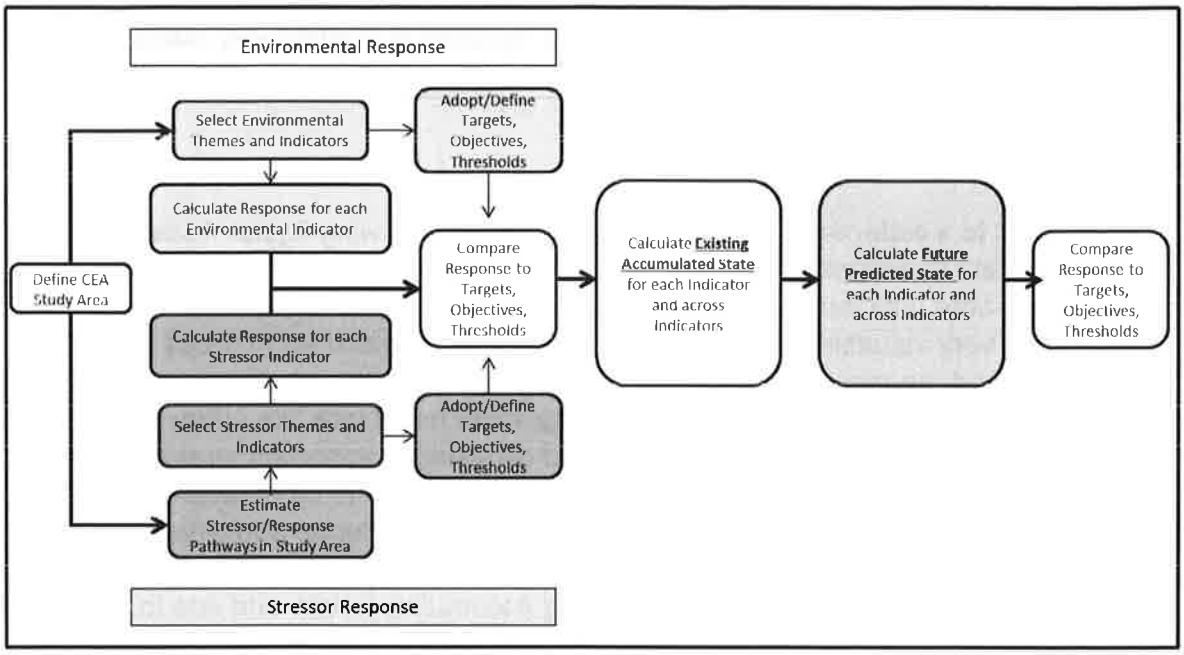


Figure 5 - Steps in the CEA process

Step 1: Definition of boundaries

This component of CEA begins with defining the boundaries of the study area for the assessment. These boundaries are application specific and can be political or administrative, watershed, or regional. In the context of watershed planning by municipalities, one would assume that the boundary would be the watershed (as delineated in the early steps of watershed planning). However, depending upon the question or the development pressures, boundaries of a CEA could be at a sub-watershed scale or could also include multiple jurisdictions depending upon the watershed size.

Boundaries can also be based on the spatial and temporal scale of a particular project, the habitat of a particular species of interest, or areas for industrial development (e.g., energy reserve boundaries). Boundaries must consider the spatial location but also the period of time. It is important that the boundaries of the study area remain consistent over time for CEA.

Step 2: Selection of environmental response indicators

This can be a seemingly overwhelming component of the assessment, given the number of possible indicators and can lead to misunderstandings at multi-stakeholder tables because the hierarchical embeddedness of indicators is not organized in the same way by different participants. That said there are only a handful of environmental themes to consider as well as core indicators under each theme which narrows the field

for CEA without compromising the quality of the assessment. In addition, not all indicators and themes are necessary for all areas as mentioned above.

When different knowledge systems are included within a watershed CEA, such as Indigenous knowledge, the organizational structure of indicators requires significant thought to demonstrate the related and inclusive nature of indicators and where linkages across knowledge systems may or may not occur.

Step 3: Measure changes in environmental response indicators relative to benchmarks

Environmental indicators measure the environmental response. Simply tracking changes in water quantity over time or across a watershed is one way to measure the environmental response based on one indicator under one environmental theme. Measuring the environmental response across multiple indicators starts to build the broader assessment for CEA. Reporting on environmental response is often called an effects-based assessment in the published scientific literature. It can indicate areas and indicators of higher environmental risk based on the magnitude, direction and type of change in environmental response relative to a baseline. At times, this is the only output of interest to a particular stakeholder group or end user.

Step 4: Estimate stressor/environmental indicator response pathways

Indicators are used to inform decision-making about environmental conditions and risks, so they must be based on a reasonable understanding of relationships (and potential change) between the environmental indicator and effects on that indicator from development (stressors). Mapping out stressor to environmental response pathways is one way to focus a CEA to development types, stressor indicators associated with the development type, and the environmental responses one might expect to be potentially affected by this development type. Some call these stressor/response pathways or adverse outcome pathways.

Step 5: Selection of stressor indicators

Stressor indicators associated with different development types measure the stressor response. These can include linear features (e.g, roads, seismic lines), point source discharges (e.g., effluent discharges, air emissions), non-point source discharges (e.g., agricultural run-off), etc. Stressor indicators are selected based on known and planned developments within the watershed or sub-watershed. Not all stressors must be measured to conduct a CEA for a watershed. The stressors of highest risk or known priority serve as a starting point.

It is important to note that the condition of the environment can be changed by anthropogenic stressors from specific developments, and also by natural stressors such as fire, disease, and insects. Climate change is also a major factor requiring

consideration in both existing accumulated state assessments and future predicted state assessments. Hence many decision support or Decision Support Software (DSS) tools include different climate change models to "adjust" response estimates in consideration of the cumulative effects of contributing changes in climate.

Step 6: Measure changes in stressor indicators relative to benchmarks

It is important to measure and report on the changes in stressors over time and space on the landscape and within the watershed boundary to understand how the land use has changed and the drivers that may be contributing to changes in environmental response indicators. Measurement and reporting on the stressor response for one or many indicators is the second core output of a CEA and associated decision support tools. Reporting on the stressor response is often called a stressor-based assessment in the published literature. It can indicate areas and indicators of higher development pressure relative to a baseline. Many regulatory agencies have approval limits and planning thresholds associated with stressor response indicators (e.g., SO_2 emission limits for example). At times, this is the only output of interest to a particular stakeholder group or end user in a watershed.

Step 7: Calculate existing environmental state or condition

The stressor and response assessments are then integrated to generate the existing accumulated state assessment. This assessment illustrates what has changed where and by how much for both stressor indicators and environmental response indicators. A simple example is shown below. Understanding the key stressors that may be affecting the environmental response is fundamental to understanding risk within a watershed due to development e.g., trends in nutrient loadings over time within a watershed (environmental response), resulting in increased algal biomass (environmental response) due to point and non-point source releases (stressors) and the risk this poses to assimilative capacity of the watershed to increased population growth or a proposed additional nutrient load which may be a component of a watershed plan.

Targets, Objectives and Thresholds

Measuring the environmental response and determining if changes have occurred due to development stress is not sufficient in and of itself to evaluate risk or to trigger management actions. Changes in the response of environmental indicators as well as stressor indicators must be evaluated against targets, objectives and/or thresholds (i.e., benchmarks) in order for the significance, magnitude and direction of the responses to be determined.

If government policy or planning exists within an area, often indicators are identified in those plans and have objectives and thresholds assigned to them. An example may be a land use plan or in this case a watershed plan with associated indicators and

thresholds assigned to that plan. Another example may be water quantity limits for a particular reach or watershed. An inventory of existing government policies, plans, indicators and benchmarks within an area is always the first place to start to support both indicator selection as well as benchmark selection.

Benchmarks that are familiar to many are water quality guidelines. National or provincial criteria applied to an environmental response indicator (in this case a water quality parameter or parameters, such as those outlined in PPS are often used to assess if changes in water quality pose a risk. While these are a quick and ready for use approach, these benchmarks often do not consider the site, reach, sub-watershed or watershed specificity.

Watersheds are dynamic systems with indicators that operate within a range specific to that watershed, sub-watershed and/or reach. Applying benchmarks that do not consider this specificity often result in false positives with respect to environmental change (e.g., guidelines are exceeded in the absence of a stressor effect simply because of natural surficial geology for example). Benchmarks specific to the study area are often calculated from monitoring data within that area as a baseline. This can be done using data from a "lesser developed site" in the area or from the area at a time period where development was less. These benchmarks capture the natural variability of the indicator considering a lesser developed condition of the watershed in space or time. If the indicator then changes outside of that natural variation of the baseline condition, this can be a very effective and specific way to assess the risk of a change or potential change in a watershed.

Finally, the outcomes predicted from a predictive model can also be plotted on the same tracking graphs as targets, so the trajectory or differences between actual and predicted can be assessed regularly; are we on course or off course to our predictions or planning targets?

Changes in an indicator can only be assessed relative to a benchmark. Thus, benchmarks are essential to CEA and to measure the magnitude, direction and hence significance of change in both environmental response indicators and stressor indicators. If changes are occurring but the condition of the indicator remains below a benchmark, then this is of lower risk than a change that has resulted in an increase over a benchmark. Translation of CEA results into risk based on the changes measured in indicators is critical to support risk-based decision-making and cumulative effects management within a watershed.

There is another important element of the use of benchmarks that creates the opportunity for CEA. The challenge most often faced in CEA is not in assessing change in a single indicator, but how to integrate change assessments across multiple indicators for a true assessment of cumulative effects. The location, distance or deviation of an indicator relative to its benchmark is a measure that can be applied to any indicator/benchmark and hence can be used to integrate measures of change

across many different indicators and their associated benchmarks within the study area. This essentially results in the key output of the existing accumulated state assessment which is a "change map" or a risk map by indicator or across indicators for an area. The indicators which are showing the greatest changes in an area are typically of higher concern requiring some form of action or further investigation.

Predicted Future State

The previous section discussed the process of assessing the current or existing environmental state. This is important to track changes and to support current management of the landscape and watershed. It identifies areas of higher and lower risk and indicators that may require more protection or attention than others. This change assessment can be used to respond to new developments proposed in an area. It also requires monitoring data to implement.

Watershed planners examine future developments on a landscape and predict what the environmental responses might be (or not) relative to the development activities. This is where predictive models are used to forecast what the future might look like under different scenarios and considering the current trajectory of development (changes in stressor indicators) and associated environmental response (as measured in the existing accumulated state assessment).

Predictive models often play a role to support land use and watershed planning and accumulated state assessments. Using monitoring data can help track over time if predictions were accurate. There are many different types of predictive models; some can predict river flows using different parameters that affect surface water quantity (e.g., precipitation, soil moisture, runoff, etc). Others can show different species modelled on the landscape reflecting intactness of biodiversity.

The same steps used in the accumulated state assessment also apply in the predicted future state assessment.

Cumulative Effects Management (CEM)

CEA translates into enhanced environmental protection and management of cumulative effects (CEM) when the context of environmental risk informs decision-making within government, industry or with stakeholders. CEA produces risk maps for indicators and in areas where environmental change is occurring due to development activities and relative to benchmarks. Working with stakeholders, one can determine no action, low action, moderate and high action responses to movement towards or exceedances of benchmarks.

The first step is always to conduct quality assurance and quality control (double check) of the data and analysis to confirm the result. One might then continue to monitor the situation, increase monitoring, decrease monitoring, apply mitigation, or initiate stakeholder discussions. If information is tracked and reported but changes are not

linked to actions, then the value of the exercise is arguably academic. Decision-makers and stakeholder appreciate receiving `flags` of changes that are occurring and suggested actions to take. Having this automated through a decision support system is ideal. It is also ideal as part of a project to discuss and outline actions tied to benchmarks at the beginning of the project with agreement to adapt over time as necessary.

Decision Support Software Tools

Data and information systems and decision support tools are critical for implementation of the cumulative effects framework. With the advance of big data, public access to government data, the volumes of different stressor and monitoring data sets, advancement of technology and real time monitoring, the sophistication of comparative analysis and calculation of benchmarks and the need for geospatial representation-software systems are the only way CEA can be effectively and systematically implemented on the ground and within watersheds.

A system must enable the integration of monitoring data, spatial data, environmental and stressor indicator status, predictive modelling, benchmarks (objectives, targets and thresholds), and risk and action communication (CEM). It has been discussed in the literature of who should be responsible for development of such a system. Industry for example, has raised the issue in the literature a number of times indicating how difficult, expensive and unrealistic it is for project proponents to carry the burden of assessing their project application relative to cumulative effects where they are required to conduct regional CEA as a single project proponent. The jurisdictional complexity in Canada also makes it difficult for a single government agency to implement and manage the DSS tools.

The private sector can play a significant role in development and implementation of DSS tools for CEA and CEM to serve different end users by:

- Accessing consistent data from environmental monitoring programs across sectors and jurisdictions,
- Calculating existing accumulated state using consistent indicators, benchmarks and methods,
- Using consistent modelling approaches to predict future environmental state due to different development trajectories,
- Developing long term relationships with science, technology and data providers to support on-going access and innovation for tool development,
- Working with Indigenous peoples to integrate western science with traditional ecological knowledge into environmental monitoring data, and
- Creating a data and analysis platform that is open, transparent and informed to assess environmental change and risk due to development, consider the implications of factors such as climate change to these assessments, report out

on conditions in an unbiased, science-based manner, and to identify and flag management actions for end users as changes are detected.

6.7 ASSESSMENT OF LAND USE & MANAGEMENT SCENARIOS

What is it?

This phase of plan development considers alternative measures that may be used to protect, enhance, or rehabilitate the environmental features identified in the watershed issues and goals. Watershed planning is a strategic planning exercise where the intent is to maximize benefits to the watershed as a whole, and to minimize the efforts and costs needed to formulate planning decisions and provide for protection of hydrologic features, functions, and linkages.

A key part of this strategic planning exercise is to consider alternatives – i.e. alternative approaches, alternative scenarios, alternative measures. It needs to explore what is needed to achieve the goals in terms of actions and policies. These considerations might include costs, affordability, public acceptance, timing, legitimacy, feasibility, likely effectiveness, and the degree of ease or difficulty of implementing certain measures.

Before alternative scenarios are considered for various resource features, for example, different general approaches to resource management can be identified as possible courses of action, including: pollution prevention, pollution control, regulatory control, land use policy/planning, water conservation, and habitat enhancement.

The assessment of land use and management scenarios, and determination of preferred alternatives, is based on watershed characterization and watershed-specific targets or thresholds. Public, stakeholder, and Indigenous engagement will also provide valuable direction for assessing and selecting management approaches and scenarios. Assessments will consider existing and proposed land uses and servicing, as well as options for potential management alternatives, to identify recommended watershed plan actions and policies.

Typically, land use and management scenarios consider the **state** of the watershed under current conditions (e.g., baseline characterization), and also from **pressures** and **impacts** associated with future land use (e.g., approved growth and development) and management scenarios and actions (e.g., watershed plan recommendations, protected natural heritage system, BMPs implemented, etc.). From simple desktop analyses with existing information to complex computer models, these scenarios can be developed through a range of approaches depending on the development pressures on the watershed, geographic scale, and complexity of contributing factors.

Land use and management scenarios and alternatives can be mapped as a 'blueprint for change', showing the desired future condition of the healthy, resilient watershed as

well as areas for protection, restoration, and enhancement. This type of mapping can present a cumulative illustration of land use, growth, development, natural heritage and riparian protection, and resource management across the entire watershed. In turn, this allows for a coordinated systems approach to managing ecosystem impacts rather than reacting to project-specific development impacts.

For example, land use and management scenarios can illustrate the identification and protection of water resource systems (surface water features and areas, ground water features and areas, hydrologic functions, key hydrologic features, and key hydrologic areas), interconnections and linkages with natural heritage systems, and approved or proposed land use changes and development. Areas in the watershed can be identified where growth should or should not be accommodated, where servicing or infrastructure will not result in negative impacts to quality and quantity of water, and areas where restoration or best management practices should be implemented.

Why is it important?

Assessment of land use and management scenarios will assist municipalities with implementing PPS direction regarding water by supporting decisions on watershed plan recommendations for minimizing impacts, and by supporting decisions on potential development restrictions or alternative development approaches. PPS requires that planning authorities: minimize potential negative impacts; and implement necessary restrictions on development and site alterations to protect vulnerable surface and groundwater, sensitive surface water features and sensitive groundwater features, and their hydrologic functions. Also, mitigative measures or alternative development approaches may be required to protect, improve, or restore sensitive surface water features, sensitive groundwater features, and their hydrologic functions (PPS 2.2.2). By assessing existing and proposed land uses/development/infrastructure and potential mitigative actions/policies, municipalities can determine preferred management approaches which will meet watershed objectives and targets.

Growth Plan and Greenbelt Plan definitions for watershed planning provide that watershed planning typically includes scenario modelling to evaluate the impacts of forecasted growth and servicing options and mitigation measures.

Growth Plan and Greenbelt Plan definitions for subwatershed plans provide that a subwatershed plan should consider existing development and evaluate the impacts of any potential or proposed land uses and development. A subwatershed plan also identifies specific criteria, objectives, actions, thresholds, targets, and best management practices for: development, water and wastewater servicing, stormwater management, managing and minimizing impacts related to severe weather events, and supporting ecological needs. Assessment of land use and management scenarios will assist municipalities in determining impacts of development and mitigation measures, as well as pinpointing specific actions and best management practices.

ORMCP requires that watershed plans must include criteria for evaluating the impacts of proposed development and infrastructure projects within and outside the plan area on water quality and quantity and on hydrological features and functions. Evaluations of the assimilative capacity of the watershed to deal with sewage, and assessments of climate change impacts on sewage and water systems and stormwater management systems, are also necessary. With regard to development and site alteration in subwatersheds, it is necessary to consider extent of vegetated and pervious surfaces, and whether a development proposal will contribute to meeting these targets.

There is a wealth of available information regarding existing land uses, allocations of growth and servicing, approved and proposed development, and infrastructure strategies at the provincial, upper-tier, and lower-tier municipal levels. For example, where growth forecasts and intensification targets have been set out in the Growth Plan Schedule 3 and subsection 2.2.2, municipalities are able to undertake a land needs assessment to determine the amount of land needed to accommodate forecasted growth and associated infrastructure (preferably within settlement areas). Layered on the land use and growth management analyses, natural heritage and hydrologic features and areas can be identified in terms of areas for protection, restoration, or enhancement. Factoring in potential best management practices and potential criteria for development and infrastructure, municipalities can identify whether or not proposed land use and management alternatives will be successful in meeting stated watershed/subwatershed objectives or targets. In the case of an urbanizing watershed, for example, scenario analyses might indicate that there is insufficient natural cover (wetlands and woodlands) to meet targets, and management alternatives such as increased minimum vegetated areas in plans of subdivision might be identified as a watershed plan recommendation to inform land use planning.

As described previously, natural heritage and hydrological scenarios can be conceptualized in the form of mapping. Municipalities can identify elements of the water resource system and key hydrologic features and areas, including areas for protection and restoration, to determine if the proposed scenario will achieve their outlined watershed objectives. The watershed plan for Bowmanville/Soper Creek provides a useful example of an outlined scenario development process for its natural heritage system and hydrologic systems, and is described in a case study in this section of the Watershed Planning Guidance.

Many municipalities and conservation authorities have experience with management of natural hazard risks through analysis of flooding scenarios, and application of policies and land use designations to direct growth away from flooding hazards and other natural hazards and constraints. A similar approach can be used in watershed planning at the municipal level, where features and linkages of the water resource system are identified, and analysis of growth scenarios highlight areas where growth should be carefully managed to avoid negative impacts.

How to do it?

Step 1: Identify, Map, and Evaluate Existing Land Uses, Development/Infrastructure Approvals, and Growth Forecasts

All upper and single tier municipalities within the Growth Plan area must determine growth management strategies and land budget approaches for accommodating projected future population and employment forecasts.

The Growth Plan now requires upper- and single-tier municipalities to assess the quantity of land required to accommodate forecasted growth, including decisions about settlement area boundary expansion and the quantity of excess land, using a standard methodology to be issued by the Province. Additionally, in the Growth Plan, minimum targets for intensification and density have been identified.

Official plans, zoning bylaws, source protection plans, draft approved development, and land budget analyses can provide information on existing and proposed land uses and development on a watershed basis.

Step 2: Identify, Map, and Evaluate Water Resource Systems, Key Hydrologic Features and Areas, Hydrologic Functions and Linkages, Associated Natural Heritage Features, and Impervious Surfaces

As identified through watershed characterization, the features, functions, and linkages of the water resource system, key hydrologic features and areas, natural heritage features and areas, source protection areas, riparian areas, and impervious surfaces, should be mapped.

Building on the existing and proposed land use analysis, an evaluation of whether areas for protection, restoration, or enhancement can assist with determining whether management alternatives will meet stated watershed objectives and targets. For example, in a watershed where key hydrologic features and natural heritage features are identified, a management alternative such as protection of these features and enhancement of linkages between these features might assist with meeting a target for minimum natural cover and riparian areas within the watershed.

Step 3: Determine Management Alternatives and Actions

Recommended actions will be determined as a result of the evaluation of watershed conditions and issues relative to goals by means of management scenarios with alternative actions. At this point, there should be a fairly clear notion of what actions are needed to meet management goals and objectives in each part of the watershed. To promote ecosystem protection, appropriate initiatives by municipalities should be developed and stated for key natural heritage and water-based elements that are necessary for protecting ecosystem health. Within their watershed management plans,

municipalities should set out recommended actions for each ecological area in the watershed in terms of:

Management Categories

- protection;
- enhancement/improvement; and
- rehabilitation/restoration.

Natural and Hydrologic Areas

- water resource systems;
- key hydrologic features and areas;
- key natural heritage features;
- natural heritage systems; and
- parks, open spaces, and green infrastructure.

Natural resource managers can take advantage of overlaps and interrelationships among categories of management goals to maximize the use of available fiscal and human resources. For example, a **protection** action might be aimed at maintaining ground water discharge characteristics and habitat quality for an existing brook trout population. An **enhancement** initiative might be aimed at constructing five brook trout spawning areas, while a **rehabilitation** action could be aimed at restoring ten kilometres of lost brook trout habitat. Finally, the plan should provide a description of how environmental monitoring should be used to measure the success of watershed management decisions or actions.

The plan can provide technical guidance for **rehabilitation**. Criteria for prioritizing site rehabilitation should also be established by municipalities, including estimated time, fiscal and human resources required for each site. Corrective actions for existing problems should be described, including technical descriptions of how these proposed changes are expected to occur. The watershed management plan can outline preferred measures or strategies for improved land management and for the abatement of all point and non-point sources (e.g., stormwater management facilities, water pollution control plant facilities).

When developing watershed plans, municipalities and watershed practitioners should also take into account whether the proposed management actions will be sufficient to meet stated watershed targets, as well as applicable federal and provincial standards (if these have not been incorporated into targets already). Management actions which contribute to watershed goals and are realistic for the local watershed context/capacity should be incorporated into watershed plans as recommendations and policies, which can then be integrated into land use planning documents and approval processes.

A desired management approach will:

- Use the best available information;

- Address the needs of the ecosystem as well as human needs;
- Involve all stakeholders and interested parties;
- Recognize and account for uncertainties;
- Recognize cumulative effects;
- Use an adaptive management approach; and
- Be realistic for the watershed conditions and capacities of implementing authorities.

It is important that municipalities within a particular watershed collaborate to ensure collective consideration and incorporation of information on potential effects on or responses by (positive, neutral and negative) the watershed environment into decisions on land use planning as guided by their Official Plans. The intent of which is to find creative solutions that ensure future land use changes make a positive contribution to the ecosystem as a whole, rather than achieve the narrow ends of certain isolated interests.

In developing watershed plans, municipalities and watershed practitioners will take into account whether the proposed management actions will be sufficient to meet stated watershed targets, as well as applicable federal and provincial standards. Management actions which contribute to watershed goals and are realistic for the local watershed context/capacity should be incorporated into watershed plans as recommendations and policies, which can then be integrated into land use planning documents and approval processes.

Step 4: Costs and Benefits

It is recommended that municipalities also consider a cost-benefit approach to evaluating land use and management scenarios. This includes consideration of ecological and human benefits of various land use and management scenarios, while also evaluating the lifecycle costs and risks associated with different servicing/infrastructure alternatives. For example, in the case of stormwater management alternatives to accommodate forecasted growth, municipalities may consider the costs and benefits of green infrastructure and low impact development versus traditional grey infrastructure. In this example, there is a high level of benefit for a relatively lower lifecycle cost by opting for a management strategy which maximises the role of green infrastructure and source-level controls and reduces the amount of land needed for dedicated stormwater management facilities. However, a cost may be that there is decreased municipal control and certainty over stormwater volume and contaminant attenuation in areas with low levels of permeability and vegetative cover.

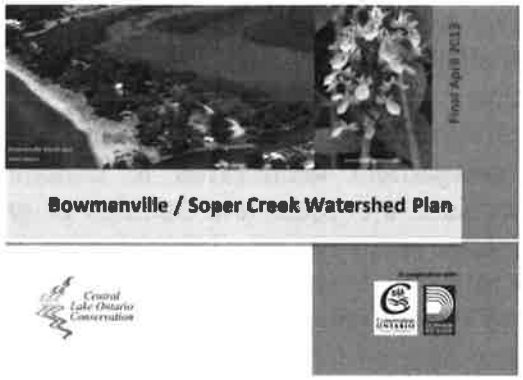
A mixed qualitative / quantitative approach may be effective in assigning cost and benefit values to a comprehensive list of key components in each land use or management scenario. This analysis would compare existing and proposed conditions and, similar to the Class Environmental Assessment process, alternative scenarios

would be tested and the highest scoring options against a series of criteria (i.e. cost-benefit) would be short listed for further consideration. Municipalities can therefore undertake a scenario analysis that broadly considers costs and benefits with regard to the following features:

- Peak flow attenuation and floodplain management
- Water quality
- Erosion and stream morphology
- Natural heritage features
- Water balance and infiltration
- Urban stormwater runoff
- Agricultural / rural runoff
- Groundwater quality and quantity
- Socio-economic opportunities
- Health and well-being
- Carbon foot print
- Preservation of EG&S

Example of Scenario Analysis: Bowmanville/Soper Creek Watershed Plan Scenarios

An example of the assessment of land use and management scenarios in watershed planning can be found in the *Bowmanville/Soper Creek Watershed Plan*.



The watershed plan outlines ORMCP requirements for development of watershed plans, highlighting that "ORMCP requires Authorities developing watershed plans to set watershed targets and develop management alternatives to assess whether or not the existing or predicted conditions within the watershed satisfy the targets identified. The examination of the management options is meant to evaluate the ability of each option to maintain, improve or restore water quality and quantity, ecological integrity, feasibility of the alternative, and implementation mechanisms.

In compliance with the requirements of ORMCP and technical guidance provided in ORMCP Technical Paper #9, the analysis of land use and management scenarios was undertaken in four steps:

- Step 1: Set watershed health targets;
- Step 2: Develop computer models as tools to illustrate potential changes in the watershed;
- Step 3: Develop scenarios for use with the models to predict ecological changes in the watershed; and
- Step 4: Analyze the scenarios with the data provided from the models to determine what future scenario(s) provides the opportunity to achieve the watershed health targets.

Scenarios for analysis were outlined as follows:

Bowmanville/Soper Creek Watershed Planning Scenarios for Analysis

#	Scenario	Description
1	Existing Conditions	2011 watershed conditions (provides baseline conditions for comparison)
2a	Full Official Plan (OP) Build-out	Conditions of the watershed if all of the development approved in the OP occurred
2b	Full Official Plan (OP) Build-out + Natural Heritage System (NHS)	Conditions of the watershed with full OP Build-out plus protection of the NHS
2c	Full Official Plan Build-out + the Natural Heritage System + High Volume Recharge Areas (HVRAs)	Scenario 2b + the protection of HVRA function
3a	Full Official Plan and Whitebelt Build-out	Scenario 2a + full Whitebelt development
3b	Full Official Plan and Whitebelt Build-out + the Natural Heritage System	Scenario 3a + protection of the NHS
3c	Full Official Plan and Whitebelt Build-out + the Natural Heritage System + the High Volume Recharge Areas	Scenario 3b + protection of HVRA function
3d	Full OP and Whitebelt Build-out under Climate Change conditions	Scenario 3a under Climate Change conditions

(CLOCA, 2013, p.33 Table 1)

7 Implementation

7.1 WATERSHED PLAN & SUBWATERSHED PLAN DEVELOPMENT

What is it?

Contents of watershed plans and subwatershed plans will vary according to local watershed drivers, issues, and recommendations; however, alignment between plans across various watersheds will be valuable for understanding broader landscape-level trends across spatial and temporal scales. As such, municipalities should balance local conditions and needs with opportunities to standardize contents and formats, to support analysis of cross-watershed and cross-jurisdictional impacts across temporal and spatial scales.

A watershed plan is a product of the watershed planning process, which will generally present:

- findings of watershed characterization (baseline conditions);
- goals, objectives, and directions for protecting water resources and managing activities and resources;
- identified issues and impacts;
- preferred land use and management scenarios; and
- implementation approaches.

A subwatershed plan reflects and refines the goals, targets, and assessments of watershed planning for smaller geographic areas, having regard for local issues. It will generally outline:

- existing and proposed development/land uses and associated impacts;
- identified natural heritage features and areas, and hydrologic features, areas, and functions;
- approaches for protecting, improving, or restoring quality and quantity of water in the subwatershed; and
- specific criteria, objectives, targets, and best management practices for development, for water and wastewater servicing, for stormwater management, for minimizing risks and impacts related to severe weather, and for ecological needs.

There are many examples of completed watershed plans and subwatershed plans in Ontario and beyond (see resource section). A generic sample Table of Contents for a watershed plan might include the following sections:

Table of Contents Example

Section	Examples of Contents
Background	• Policy basis and rationale for plan development
Vision, Objectives, and Goals	• Description or 'blueprint' or desired future state • Specific objectives and goals
Watershed Planning Process	• Overview of the planning process and underlying principles guiding the planning process
Engagement and Communications	• Participants and roles • Methods and timing of input from committees, agencies, stakeholders, the public, and Indigenous communities
Watershed Conditions, Water Resource System, and Key Hydrologic Features, Areas, and Functions	• Description of watershed conditions, and/or connection to state of the watershed reporting • Description of the quality and quantity of water • Description of the water resource system • Identification of key hydrologic features, areas, functions, and linkages
Targets, Indicators, and Actions	• Agreed-upon targets, and objectives and actions identified to meet targets • Ecosystem indicators • Performance indicators • Recommended management actions • Criteria and policy recommendations for inclusion in municipal planning documents
Implementation, Monitoring, and Adaptive Management	• Timelines, roles, and responsibilities for implementation • Performance monitoring • Ongoing engagement and communication with implementing actors and stakeholders • Adaptive management strategy to keep the plan up to date
References and Resources	• Sources and further resources • Terms of Reference for watershed planning

Appendices	• Background studies and information, glossary

Why is it important?

The watershed plan development phase essentially confirms the preferred management scenario, and provides an implementation plan. Consultation efforts, including public open houses, surveys, online engagement, and other techniques, will be instrumental to plan development and buy-in.

In developing the watershed plan, the work undertaken in previous tasks — including watershed characterization, goals and targets, scenario assessment outcomes, and monitoring and adaptive management strategies — should be consolidated into a readable, actionable watershed plan. Watershed plans are meant to be readable documents which can be widely understood by municipalities, stakeholders, and the public, while also providing specific direction for implementation by various actors.

How to do it?

At this point in the watershed planning process, tasks including watershed characterization, goal-setting, development and assessment of scenarios, and development of recommended management approaches have been completed. These elements should be consolidated into a plan. The goals, objectives and targets set through watershed planning should be used to guide the design of an implementation plan or strategy. At the most basic level, an implementation plan should consist of:

- Developing an implementation schedule (when do you anticipate meeting your targets);
- Develop monitoring components to track and evaluate progress;
- Identify technical, financial and human resource requirements to implement the watershed plan;
- Implement your management actions developed throughout section 6;
- Prepare annual work plans based on the implementation schedule, monitoring components, resources required and management actions; and
- Be prepared to report on your results and adjust as necessary.

Considerations when developing an implementation work plan:

- Does the implementation plan align with the goals, objectives and targets of your watershed plan?
- Does the implementation plan identify responsibilities and resources required?
- Does it identify a monitoring schedule?
- Are the management actions clear and implementable with dedicated resources?

- How will monitoring be conducted?
- What information will be compiled for reporting purposes?

Step 1: Determine Preferred Format and Contents

Municipalities should consider overall readability, as well as accessibility (i.e. AODA), when identifying a preferred format for their watershed plan. Conservation authorities and municipalities with completed watershed and subwatershed plans in place can provide many excellent examples of formats and contents.

Watershed planning needs to provide a framework for implementation across smaller geographic areas, such as subwatersheds. The watershed plan can be seen as an 'umbrella' plan for constituent subwatershed plans, and can provide direction on refined goals, consideration of existing and proposed development, identification of features and functions, and provisions for protecting and restoring the quality and quantity of water in a watershed or subwatershed. Watershed planning should be translatable into subwatershed-scale evaluations and plans, in support of planning and infrastructure decision-making.

Steering Committees or Working Groups will need to work to ensure that the plan is completed in a format that can be revisited and updated through adaptive management over time.

Step 2: Consider Other Deliverables and Reports Produced through Watershed Planning

Other potential deliverables as part of watershed planning might include, for example, background reports, state of the watershed reports, communications/engagement materials, and watershed report cards. Municipalities should determine how to consolidate these elements into their final plans, or provide summaries while keeping other deliverables under separate cover.

During the initial steps of watershed planning, watershed characterization can lead to the development on an 'existing conditions report' or 'characterization study report', which will provide all relevant data and information. This information is typically kept under separate cover from the watershed plan itself, or included as an appendix, to promote readability of the watershed plan.

Separate background reports for particular elements of watershed planning, such as water budgets or nutrient loading assessments, may also be required to support development of the watershed plan, depending on local watershed conditions and needs. Reports detailing engagement efforts and feedback, including Indigenous engagement, may also be produced as watershed planning progresses.

Formats and contents of Watershed Report Cards should also be discussed. Generally, indicators monitored in watershed report cards include:

Surface Water Quality

- Total phosphorus
- Bacteria (e. coli)
- Benthic macroinvertebrates

Forest Conditions

- % forest cover
- % forest interior
- % riparian zone

Groundwater Quality

- Nitrite & nitrate
- Chloride

Other potential deliverables may include a project web page, meeting minutes and reports of the Steering Committee or Working Group, fact sheets/brochures for consultation, and more.

Step 3: Develop the Plan (and Potential Official Plan Policies/Amendments), and Seek Appropriate Approvals

Once a watershed or subwatershed plan has been developed in an appropriate format, the plan should be endorsed or approved.

Official Plan Amendments or other appropriate implementation mechanisms also need to be considered.

The Watershed Planning Guidance does not intend to set specific timeframes for review and update of watershed plans. However, watershed plans need to be kept up to date to inform planning and decision-making at the municipal level. Typically, watershed planning should be undertaken alongside official plan reviews and official plan amendments so objectives and recommendations can be incorporated into municipal policy.

7.2 INFORMING LAND USE PLANNING & INTEGRATED PLANNING FOR WATER, WASTEWATER, & STORMWATER

What is it?

Watershed planning must be undertaken by municipalities, which will inform land use, development, and infrastructure planning for:

- location and feasibility of settlement area boundary expansions;
- water infrastructure planning;
- planning for new or expanded infrastructure;
- comprehensive water or wastewater master plans;
- planning for potable water, stormwater and wastewater systems;
- stormwater master plans for serviced settlement areas;
- the protection of water resource systems and decisions related to planning for growth;
- allocation of growth and planning for water, wastewater, and stormwater infrastructure;
- proposals for large-scale development outside of settlement areas by way of a secondary plan, plan of subdivision, vacant land plan of condominium or site plan; and
- infill development, redevelopment and resort development outside of settlement areas in developed shoreline areas of inland lakes.

Goals, objectives, and direction contained in watershed plans and municipal official plans for protection of water resources and management of human activities, land, water, aquatic life, and resources, will provide a basis for municipalities when evaluating growth and servicing options.

Subwatershed planning will inform land use, development, and infrastructure planning for:

- proposals for large-scale development proceeding by way of a secondary plan, plan of subdivision, vacant land plan of condominium or site plan;
- planning for designated greenfield areas;
- proposals for large-scale development outside of settlement areas; and
- infill development, redevelopment and resort development outside of settlement areas in developed shoreline areas of inland lakes.

Subwatershed plans identify specific criteria, objectives, actions, thresholds, targets, and best management practices for development, for water and wastewater servicing, for stormwater management, for managing and minimizing impacts related to severe

weather events, and to support ecological needs. Based on pre-development monitoring, the subwatershed plan considers existing development and evaluates impacts of potential land uses and developments.

"Informed by" is not a defined concept or term in provincial land use planning policy. However, there are a range of requirements for land use planning and infrastructure decision-making to be informed by watershed planning or subwatershed plans, as applicable. "Informed by" should generally mean that watershed conditions, objectives, targets, criteria and other direction of watershed/subwatershed planning provide the basis for decisions on protecting, improving or restoring water quality and quantity.

Why is it important?

Watershed planning processes typically include the development and assessment of scenarios, and development of recommended management approaches, which may be included in official plan amendments, zoning bylaw amendments, subdivision agreements, and more detailed subwatershed studies, among other implementation approaches.

Objectives and requirements identified through watershed planning will be implemented into municipal official plans, to inform decisions on land use, growth, and infrastructure. Official plan designations and policies relating to long-term protection of key hydrologic features, areas, and functions, as well as the water resource system, will also be applied in official plans. Hydrologic functions, including quality and quantity of surface and ground water, will need to be protected where applications for development or infrastructure are anticipated or underway. Watershed plans and subwatershed plans will provide applicable standards, criteria, targets, or direction for development of new infrastructure and for supporting applications for major development. Consistency of water, wastewater, and stormwater management planning with applicable watershed and subwatershed plans, will need to be determined by municipalities where there are applications for major development or new/expanded infrastructure.

Typically, higher-level watershed planning will inform water, wastewater, and stormwater master plans as well as settlement area boundary expansions and decisions on allocation of growth. Land use designations and policies implemented in municipal official plans will show areas where growth can be accommodated without causing a negative impact to water resource systems and hydrologic functions.

Under the framework of a watershed plan, locally-specific subwatershed plans will inform stormwater management plans, proposals for major development in key hydrologic areas outside of settlement areas, proposals for development in developed shoreline areas, and planning for designated greenfield areas. This will be achieved by consideration of standards, criteria, and objectives outlines in the plans themselves along with official plan policies and designation recommended through watershed/subwatershed planning. Alignment of municipal comprehensive reviews,

official plan reviews/zoning by-law reviews, master planning/secondary planning processes, major development applications, and infrastructure planning with watershed or subwatershed planning, will contribute to an integrated approach to protection of quality and quantity of water and hydrologic features, areas, and functions.

The *Environmental Assessment Act* provides for protection, conservation, and wise use and management of the environment by setting out a decision-making process to address potential effects of municipal infrastructure projects, which may be either Individual or Municipal Class Environmental Assessments (EAs). Watershed planning and subwatershed plans should be undertaken in a way that is complimentary to EA processes, which may streamline infrastructure approvals in the future.

How to do it?

Step 1: Determine whether watershed planning, subwatershed planning, or both are relevant to the development or land use proposal

Land use, development, and infrastructure planning and decision-making will be informed by **watershed planning**, by **subwatershed planning**, or by **either watershed planning *or* subwatershed planning**. In some cases, municipal official plan policies will be implemented to provide for protection of quality and quantity of water, key hydrologic features and areas, water resource systems, and hydrologic functions. Other criteria may need to be met as well to guide decisions on development, such as consistency with stormwater management plans, water/wastewater/stormwater master plans, water budgets, approved source protection plans, environmental assessment, or other relevant studies.

Planning, design, and development restrictions and requirements should be rooted in the findings of watershed characterization,

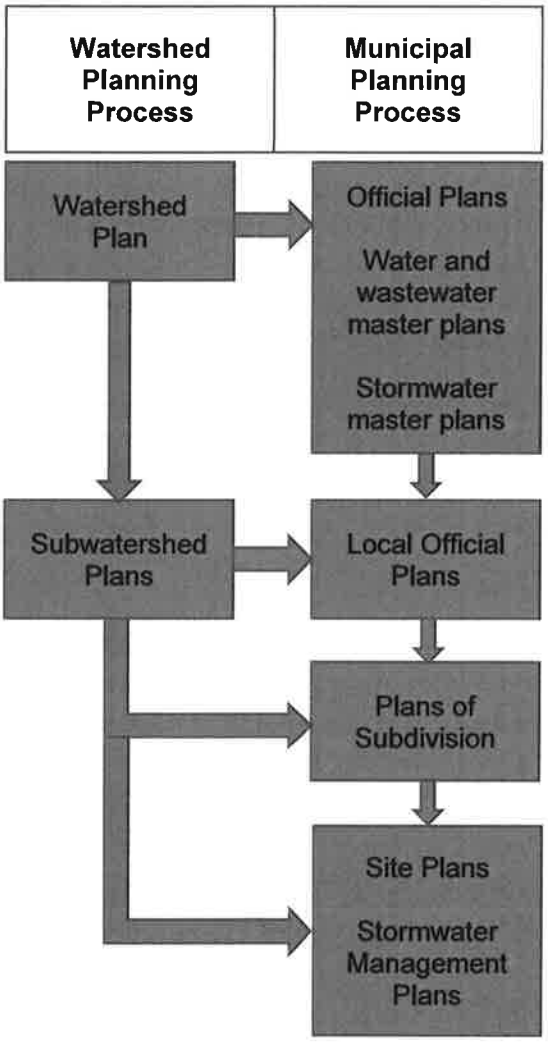


Figure 6 - Watershed and municipal planning (draft)

watershed goals and targets, and detailed studies addressing watershed-specific issues. Ongoing monitoring during implementation and adaptive management will help to determine if planning, design, and development restrictions are successful in protection of water and management of land uses and resources. The results of other watershed pilot projects, academic studies, and implementation experiences in other jurisdictions will assist with developing planning, design, and development requirements.

The integration of watershed planning with municipal land use planning, is illustrated in Figure 6. Timing and sequencing of growth allocation and boundary expansion decisions should be aligned with watershed and subwatershed planning. Where growth is anticipated, watershed planning should be initiated as early as possible in the process. For example, where development and secondary planning are proposed for a designated greenfield area, subwatershed planning will need to be undertaken in concert with the secondary planning process and stormwater management planning processes.

This integration allows for implementation of watershed planning through land use planning and policy at various stages of planning and development processes. For example, where development and secondary planning are proposed for a designated greenfield area, subwatershed planning will need to be undertaken in concert with the secondary planning process and stormwater management planning processes.

A key implementation mechanism for watershed planning at the municipal level is integration of watershed planning objectives and recommendations into municipal planning processes and documents.

Step 2: Consider alignment with Environmental Assessment approaches

The *Environmental Assessment Act* provides for protection, conservation, and wise use and management of the environment by setting out a decision-making process to address potential effects of municipal infrastructure projects, which may be either Individual or Municipal Class Environmental Assessments. If an application pertains to a municipal sewage or water infrastructure proposal, it may be subject to the environmental assessment process.

Municipal Class EAs typically apply to routine public sector projects, such as municipal water and wastewater infrastructure upgrades and transportation projects. The Class EA process allows municipalities to plan, design, construct, maintain, rehabilitate, or decommission municipal infrastructure projects without the need for project approval under the *Environmental Assessment Act.*

Currently, Class EA projects are classified in terms of their environmental impact in Schedules A, A+, B, and C, which each have corresponding requirements to complete

Phases 1 through 5 depending on the project's Schedule. The Phases of Class EAs are provided in the Municipal Class EA Manual.

With regard to source water protection considerations, development proponents undertaking a Municipal Class EA must identify early in the process whether the project is or could potentially be in a vulnerable area (i.e., WHPA or IPZ), and projects which create new vulnerable areas will be incorporated into source protection plans and assessment reports. Engagement with conservation authorities or source protection regions/areas is also recommended.

EA principles can be aligned with the subwatershed planning process, to increase efficiency; many of the Act requirements for specific projects could be met through the subwatershed plan. The information developed through this planning process could be subsequently built upon to satisfy outstanding EA requirements. Municipalities and watershed practitioners interested in harmonizing the subwatershed and EA planning processes should review the current EA requirements for the types of projects that could be anticipated as a result of subwatershed planning, and integrate climate change considerations into EA processes. This will help to determine what specific EA requirements need to be incorporated into subwatershed planning.

Step 3: Use watershed or subwatershed planning objectives, targets, monitoring, scenarios, and recommended official plan policies to evaluate feasibility and impacts of development or infrastructure

Timing and sequencing of master planning, growth allocation, and boundary expansion decisions should be aligned with watershed and subwatershed planning. Where growth is anticipated, starting watershed planning as early as possible in the process is beneficial, since baseline monitoring and engagement aspects will take time.

Where watershed or subwatershed plans (or equivalent) are not yet in place, the transition provisions of the provincial plans address how to proceed with development applications.

- **Location and feasibility of settlement area boundary expansions, and planning for water, wastewater, and stormwater master plans/management plans**

Watershed planning will inform settlement area boundary expansions by outlining land uses and areas where protection, restoration, or enhancement are required to meet objectives for protection of quality and quantity of water, water resource systems, and hydrologic functions. For example, in undertaking a municipal comprehensive review and determining the need for a settlement area boundary expansion, a municipality can look to the watershed planning 'blueprint map' to identify areas appropriate for accommodating forecasted growth.

- **Protection of water resource systems**

Water resource systems will be identified, informed by watershed planning. This means that watershed characterization will provide background information for identification of water resource system components and linkages, and municipal official plans will provide for their long-term protection (through land use designations and policies).

- **Allocation of growth and planning for water, wastewater, and stormwater infrastructure**

Decisions will be informed by watershed planning. Growth should be directed to areas outside of identified areas for protection, restoration, or enhancement, outside of water resource systems, and outside of key hydrologic features and areas and linkages. Infrastructure and servicing should be assessed to ensure that there will be no negative impacts, including cumulative, cross jurisdictional, and cross watershed impacts.

- **Proposals for large-scale development outside of settlement areas by way of a secondary plan, plan of subdivision, vacant land plan of condominium or site plan**

Outside of settlement areas, proposals for large scale development in key hydrologic areas proceeding by way of subdivision, vacant land condominium, or site plan, may be permitted within a key hydrologic area where it has been demonstrated that hydrologic functions (including quality and quantity of water) will be protected, enhanced, or restored through meeting criteria and direction set out in applicable watershed planning or subwatershed plans.

- **Infill development, redevelopment and resort development outside of settlement areas in developed shoreline areas of inland lakes**

Infill development, redevelopment, and resort development may be permitted in developed shoreline areas of inland lakes (that are designated and zoned for concentrations of development as of July 1, 2017) subject to *meeting criteria and direction* set out in applicable watershed planning or subwatershed plans.

- **Proposals for large-scale development proceeding by way of a secondary plan, plan of subdivision, vacant land plan of condominium or site plan**

Decisions will be informed by watershed or subwatershed planning. Growth should be directed to areas outside of identified areas for protection, restoration, or enhancement, outside of water resource systems, and outside of key hydrologic features and areas.

- **Planning for designated greenfield areas**

Decisions will be informed by subwatershed planning. Growth should be directed to areas outside of identified areas for protection, restoration, or enhancement, outside of water resource systems, and outside of key hydrologic features and areas.

Infrastructure should be assessed to ensure that there will be no negative impacts, including cumulative, cross jurisdictional, and cross watershed impacts.

- **Proposals for large-scale development outside of settlement areas**

Decisions will be informed by subwatershed planning. Growth should be directed to areas outside of identified areas for protection, restoration, or enhancement, outside of water resource systems, and outside of key hydrologic features and areas.

- **Infill development, redevelopment and resort development outside of settlement areas in developed shoreline areas of inland lakes**

Decisions will be informed by watershed **or** subwatershed planning.

- **Permitting development in subwatershed (in ORMCP)**

Municipalities should monitor and ensure that development applications inside and outside of settlement areas meet minimum requirements for vegetated and pervious surfaces.

Information Sources

Additional information on approaches and tools can be found in the following publications:

- MOECC, 2003. Stormwater Management Planning and Design Manual
- MOECC, 2017. Guide for Consideration of Climate Change in EAs
- MOECC, 1994. 'Blue Book'
- MOECC, 1994. 'Green Book'
- Totten Sims Hubicki Associates (2001) Stormwater Pollution Prevention Handbook

Examples of integration of watershed planning with municipal land use and infrastructure planning

Municipalities of the Grand River Watershed – Integrated Water Management Plan

The plan is an integrated water management plan with goals to ensure sustainable water supplies, improve water quality, reduce flood damage potential and increase resiliency to climate change impacts. It is a joint, voluntary plan by municipalities, First Nations, local conservation authority, provincial and federal governments. The plan identifies objectives, targets and indicators to measure changes in water conditions and the effectiveness of the plan recommendations, and includes a wide

range of actions involving planning (including land use, infrastructure, watershed related), operations and research. Some key recommendations focus on protecting groundwater recharge and discharge areas, promoting water efficiency, and maintaining up-to-date long-term water supply master plans, drought management plans (including low-flow thresholds for aquatic life), wastewater treatment plans through subwatershed studies, stormwater management plans, and stormwater infrastructure vulnerability assessments to consider climate change impacts.

Municipality of Clarington – Watershed Plans

As part of their official plan review, the Municipality of Clarington undertook a watershed planning study of two small urban watersheds (Robinson and Tooley Creek watersheds) which are key areas for future growth in the municipality. The watershed management plan had two main objectives: 1) protect the integrity of the existing ecological and hydrological functions, and 2) to provide the management framework to inform the Secondary Plans for employment lands within the watersheds. The planning process assessed existing conditions and future scenarios using modelling for natural heritage system planning, water budgets and impervious analysis. The plan sets a variety of targets and objectives (such as natural cover, wetlands, surface water quality, impervious area) and recommendations such as protection of a natural system and groundwater features (including significant groundwater recharge areas), minimize impervious surfaces and enhance stormwater management and on-site infiltration using low impact development techniques.

7.3 IMPLEMENTING THE PLANS BEYOND MUNICIPAL POLICY & LAND USE DECISION-MAKING

What is it?

Beyond recommendations implemented through municipal official plan policies and designations, and targets/criteria to evaluate impacts of proposed land uses and development, watershed planning may result in other recommended actions beyond the scope of municipal land use planning.

Through partnerships with other municipalities, conservation authorities, watershed planning stakeholders, the public, private development industry, Indigenous communities, and other, additional actions can be implemented.

Why is it important?

While incorporation of watershed planning recommendations into municipal policies is the primary implementation mechanism at the municipal level, it is recognized that there may be broader management actions and partnerships needed to protect, enhance, or restore water quality and water quantity beyond the specific scope of municipal watershed planning to implement provincial policy direction.

There are many implementation approaches which may be necessary to put watershed planning into action, beyond incorporation of recommendations into municipal policies and decision-making, such as engagement, education and outreach, and reporting. For example, many existing watershed plans and subwatershed plans in Ontario address air quality considerations and recreation considerations, which often fall beyond the scope of municipal land use policy and planning (unless there are recommendations for land use designation and policies in official plans to address these matters).

How to do it?

There are many programs or approaches which may be considered as part of watershed planning which fall outside the scope of municipal land use planning.

Typically, additional actions or recommendations can be undertaken by a Working Group/Implementation Committee, Steering Committee, stakeholders and partners in the watershed planning process (e.g. members of the public and conservation authorities), Indigenous community members, the public, businesses, and other levels of government.

Through the watershed planning process, the range of actions, timelines, and responsibilities should be assigned to parties with clear timelines and targets for implementation.

Progress should be tracked toward implementation of actions, as well as progress towards meeting environmental targets.

Stewardship, Education, and Outreach

Stewardship, engagement, and outreach are important considerations in implementation of watershed planning. These activities provide valuable buy-in for watershed plan implementation, as well as offering opportunities to support voluntary watershed plan recommendations and programs outside of informing land use planning and decision-making.

For example, the LSPP outlines actions and policies for developing watershed-wide stewardship networks, educations and incentive-based programs, and agri-environmental programs, which include the following:

Provincial support for agricultural and community initiatives

The Province has provided financial and technical support to agricultural and community initiatives through the Environmental Farm Plan, the Lake Simcoe Farm Stewardship Initiative, the Community Fisheries and Wildlife Involvement Program, the Managed Forest and Conservation Land Tax Incentive Programs, the Ontario Stewardship Program and other conservation and green community programs.

Through the Ontario Stewardship program, the Province provides support to county-based stewardship councils that represent the broad base of landowner and community interests in their areas. The Province facilitates partnerships and levers financial and in-kind resources for a wide variety of stewardship, education and outreach projects.

For water quality stewardship, the LSPP provides the following examples, which will be useful to consider in undertaking watershed planning:

Stewardship programming

Stewardship programming is intended to promote phosphorus reduction and pollution management by using best management practices that can be implemented by individuals on single or multiple properties. Examples include shoreline and riparian management (e.g. planting of native species) by appropriate shoreline and streamside landowners, nutrient management by farmers and municipalities, innovative and 'green' design by developers, urban planners and engineers (e.g. innovative stormwater infrastructure), and soil conservation and management on farms, mineral and aggregate resource operations, golf courses and municipal lands.

Research, Monitoring, and Reporting

Adaptive management on a watershed basis will require ongoing learning from scientific research and monitoring, and implementation experience. Research into emerging issues and innovations, such as addressing climate change or incorporating new development and design best practices, can be incorporated into watershed planning in an iterative way, as watershed plans are reviewed and updated. Municipalities should keep abreast of opportunities for research pilot projects, and partnerships with other municipalities, conservation authorities, NGOs, and academic institutions.

Citizen science programs, whether administered by large national or regional agencies, or administered through locally-developed programs, can assist with long-term monitoring and protection of hydrologic features and functions.

As previously discussed, watershed report cards provide an excellent reporting and communication tool, which should be considered in support of long-term watershed plan implementation and stewardship.

Some municipalities will have capacity to undertake targeted research programs, while others will rely on data and knowledge gained through previous watershed planning processes and external sources. Partnerships should be formed to support research, monitoring, and reporting. Coordination of reporting will minimize duplication of results, and allow for more efficient use of limited resources. Municipalities and watershed practitioners undertaking watershed planning should share data, coordinate monitoring needs, and align reporting schedules with municipal land use planning updates or new strategies.

8 Monitoring & Adaptive Management

What is it?

Monitoring

Environmental monitoring is undertaken to collect information that can impact decision-making. For example, a water quality parameter such as level of dissolved oxygen should be considered for determining if there are oxygen issues in the watershed, and if management actions to restore oxygen levels are successful. Monitoring is an important part of watershed characterization, as well as determining whether water quality and quantity parameters are changing, and whether management actions are performing effectively. Watershed planning needs to involve measurements of water parameters as well as indicators:

- **Water Measurement Monitoring:** Water measurements can include the components of the hydrologic cycle, including hydrologic features and functions. Water measurement includes climatological measurements as well as water quantity and quality measurements. It can also include groundwater quantities, surface water quantities, flow rates, and the withdrawal and discharge of water for human uses.
- **Performance Monitoring:** Performance monitoring can include developing indicators to be used to measure the success of the implementation plan, the target values, and knowing the variability of these indicators. The proponents of water management plans are responsible for monitoring and reporting.

Adaptive Management

Adaptive management is an approach associated with flexible and continuous improvement and adaptation of approaches, policies and management that should be undertaken by incorporating new knowledge and innovative design, practices and technology. Adaptive management approaches are widely utilized in resource management and ecosystem-based planning, since these approaches will help with addressing uncertainties and risk, especially in the face of climate change and other threats. In the *Great Lakes Protection Act* and Great Lakes Strategy, adaptive management is a vital principle, as described in section 2.2 of the Watershed Planning Guidance.

The key to managing uncertainty through adaptive management is the definition of watershed-specific goals, which has been completed through earlier phases of watershed planning, and the implementation of a monitoring plan to assess progress. Monitoring therefore becomes the driver for adaptive management, as it opens a feedback loop whereby iterative management processes can be evaluated.

Goals and objectives that are established during characterization and monitoring must reflect that there are limits to changes that the ecosystem can withstand and that these limits should be considered before mitigation measures are developed to accommodate future changes. Adverse effects of land use and development activities cannot always be eliminated through mitigation; criteria and restrictions for development and site alteration in certain areas may be required to protect key hydrologic features and functions.

In undertaking watershed planning, watershed characterization should be linked to environmental monitoring and performance monitoring over the course of plan development and implementation, to assist with determining the effectiveness of management strategies and providing for adaptive management. This means that comparable indicators should be considered in both characterization and monitoring, to "paint a picture" of the state, pressures, and responses of the watershed.

Why is it important?

Provincial plans provide that watershed planning and subwatershed plans are typically based on environmental monitoring plans, or pre-development monitoring. In ORMCP particularly, watershed planning policies provide for environmental monitoring plans, including a minimum of five years of pre-development monitoring. This will be helpful for municipalities in determining whether development or land use change is resulting in negative impacts to the quality and quantity of water, the water resource systems, and key hydrologic features and areas.

As provided in ORMCP Technical Paper #9, a watershed monitoring plan should be designed to evaluate the success of the watershed plan's land and water use and management strategies in achieving watershed goals and objectives. Consistent with an adaptive management approach, feedback from the monitoring should be used to:

- assess progress with respect to meeting the targets established for protecting water quality and quantity, hydrologic features, and hydrologic functions;
- trigger corrective responses or additional management actions; and
- identify if any revisions to the management goals, objectives, or targets are necessary.

Adaptive management is a fundamental part of watershed planning, including keeping the plan up to date as development and land use changes, as well as watershed plan recommendations, result in ecosystem changes.

How to do it?

Monitoring Steps

Monitoring Steps
Analyze the issues
Develop specific objectives and questions
Define impact models, indicators, protocols, sites
Establish an information management system
Establish rigorous quality assurance program
Prepare an implementation program
Analyze data and prepare reports
Practice adaptive management

To support monitoring, the watershed plan should also specify who will take responsibility for ongoing environmental monitoring within the watershed. Approval authorities may wish to consider working together to implement monitoring programs over a number of watersheds, similar to source protection areas and regions, for example.

To support adaptive management, the frequency of watershed plan revisions will depend on how often the data from the monitoring plan is reviewed and evaluated against past data (including baseline). This can be completed through reporting, which can be undertaken biannually to update stakeholders and watershed residents on progress made towards the Watershed Plan objectives and goals. Additionally, mutual collaboration through the sharing of data, lessons learned and future goals with external water practitioners can also be useful in the context of adaptive management.

Implementing Monitoring: Roles

Upper and single tier municipalities have primary responsibility for ensuring watershed planning is undertaken, partnering with conservation authorities as appropriate, as outlined in the Growth Plan and Greenbelt Plan. This means that municipalities and conservation authorities can work together to ensure that watershed plan review cycles are aligned with municipal policy review cycles, and that monitoring data is iteratively incorporated into planning and decision-making.

Watershed planning requires multidisciplinary cooperation and a range of actors along the process – from planning, to implementation, to monitoring and reporting, and finally

reviewing and evaluating plans. Continuous engagement of stakeholder committees and working groups, as well as those involved in plan development and implementation, will support monitoring and adaptive management undertakings.

Communicating Results: Watershed Report Cards

Watershed report cards are an important communication tool beyond simply monitoring and reporting. There must be buy-in for watershed planning and management at the local level, and this buy-in can be supported through effective communication and reporting with stakeholders and partners. Communications and education will be necessary to communicate the progress and success of watershed planning. Watershed report cards have potential to communicate aspects of watershed planning, especially monitoring, evaluating, and reporting. However, watershed report cards may need some revisions to improve standardization of collection protocols and comparability of indicators between watersheds.

Updating Watershed Plans

Watershed plans are living documents, which must be kept up to date as land use changes and provincial and municipal policies change. Timing of plan review and adaptation should align with municipal planning exercises, such as Official Plan Reviews, major Official Plan and Zoning By-law Amendments for secondary plans and settlement area boundary expansions etc.

Lessons learned from performance monitoring during implementation should be used to make appropriate revisions in watershed management programs.

Watershed and subwatershed plans should be up to date in order to inform land use and development decision-making.

Watershed management processes and municipal planning processes should be integrated to provide a consistent approach to protection of water resources, management of human activities, land, water, aquatic life, and resources.

9 Resources

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