12 - Hydrological Evaluations for Hydrologically Sensitive Features

1 Purpose and Overview

This technical paper provides guidance to assist landowners, developers and their consultants in preparing hydrological evaluations as required by Section 26 of the Oak Ridges Moraine Conservation Plan (ORMCP).

The ORMCP's ecosystem-based approach to Hydrologically Sensitive Features (HSF) prohibits most development or site alteration within a Hydrologically Sensitive Feature or within the related minimum Vegetation Protection Zone (VPZ). Development or site alteration within the minimum Area of Influence that relates to a Hydrologically Sensitive Feature is subject to a Hydrological Evaluation.

This technical paper is not intended to provide comprehensive guidance on all aspects of Hydrologically Sensitive Features. The reader will be directed to existing guides and references where appropriate.

2 Related Considerations

When preparing Hydrological Evaluations, it is suggested that the reader also review the highlighted, associated topic areas as discussed in the ORMCP, as shown in Figure 1 below.

Clean Water Act, 2006

The *Clean Water Act, 2006* was passed on October 19, 2006. Associated regulations, Director's Rules and technical modules are currently being developed. Readers of this technical paper should take note that the requirements of the *Clean Water Act, 2006* may have implications to initiatives undertaken to implement the ORMCP. Information concerning the *Clean Water Act, 2006* is available at: www.ene.gov.on.ca/en/water/ .

Further Reading

Please also refer to the additional list of resources and references listed at the end of this technical paper.

Figure 1 ORMCP Topic Areas and Linkages with Technical Paper 12 - Hydrological Evaluations for Hydrologically Sensitive Features

3 Requirements of the Oak Ridges Moraine Conservation Plan

The direction for preparing a hydrological evaluation stems from Part III of the ORMCP, "Protecting Ecological and Hydrological Integrity". The ORMCP contains a number of requirements aimed at protecting hydrological integrity and functions; including the preparation of a hydrologic evaluation as a key component of the ORMCP.

The Oak Ridges Moraine Conservation Plan (ORMCP) states:

26.

(1) The following are hydrologically sensitive features:

1. *Permanent and intermittent streams.*
2. *Wetlands.*
3. *Kettle lakes.*
4. *Seepage areas and springs. O. Reg. 140/02, s. 26 (1).*

(2) All development and site alteration with respect to land within a hydrologically sensitive feature or the related minimum vegetation protection zone is prohibited, except the following:

1. *Forest, fish and wildlife management.*
2. *Conservation and flood or erosion control projects, but only if they are determined to be necessary in the public interest after all alternatives have been considered.*
3. *Transportation, infrastructure and utilities as described in section 41, but only if the need for the project has been demonstrated and there is no reasonable alternative.*
4. *Low-intensity recreational uses as described in section 37. O. Reg. 140/02, s. 26 (2).*

(3) An application for development or site alteration with respect to land within the minimum area of influence that relates to a hydrologically sensitive feature, but outside the hydrologically sensitive feature itself and the related minimum vegetation protection zone, shall be accompanied by a hydrological evaluation under subsection (4). O. Reg. 140/02, s. 26 (3).

(4) A hydrological evaluation shall,

a) demonstrate that the development or site alteration will have no adverse effects on the hydrologically sensitive feature or on the related hydrological functions;

b) identify planning, design and construction practices that will maintain and, where possible, improve or restore the health, diversity and size of the hydrologically sensitive feature; and

c) determine whether the minimum vegetation protection zone whose dimensions are specified in the Table to this Part is sufficient, and if it is not sufficient, specify the dimensions of the required minimum vegetation protection zone and provide for the maintenance and, where possible, improvement or restoration of natural self-sustaining vegetation within it. O. Reg. 140/02, s. 26 (4).

(5) In the case of items 11 and 12 of the Table to this Part, the basis on which the determination and specification mentioned in clause (4) (c) is done shall include, without limitation, an analysis of land use, soil type and slope class, using criteria established by the Government of Ontario, as amended from time to time. O. Reg. 140/02, s. 26 (5).

4 Rationale for the Requirements

The ORMCP takes a comprehensive approach to water management by acknowledging the importance of water and the hydrologic cycle in an ecosystem approach. In Section 19(1) of the ORMCP, it is stated that "*the purpose of this part [Part III] is the integration of environmental and land use planning in order to maintain and, where possible, improve or restore the ecological integrity of the plan area.*" The Hydrologically Sensitive Features are strongly interconnected and provide ecological functions (as defined in the ORMCP) linked with groundwater, surface water and many natural heritage features and areas. Thus protecting the HSFs in the ecosystem will benefit the protection of natural heritage features and areas.

Two concepts are envisaged in the ORMCP: hydrological functions and hydrological integrity. Hydrological functions are the functions of the hydrological cycle, such as, but not limited to: precipitation, run-off, evapotranspiration, infiltration, and changes in storage. Hydrological integrity addresses the condition of the ecosystems in which the hydrological features and the hydrological functions are unimpaired by stresses from human activity.

5 Implementation of the Requirements

5.1 Assessing the Need for a Hydrological Evaluation

A hydrological evaluation is required for:

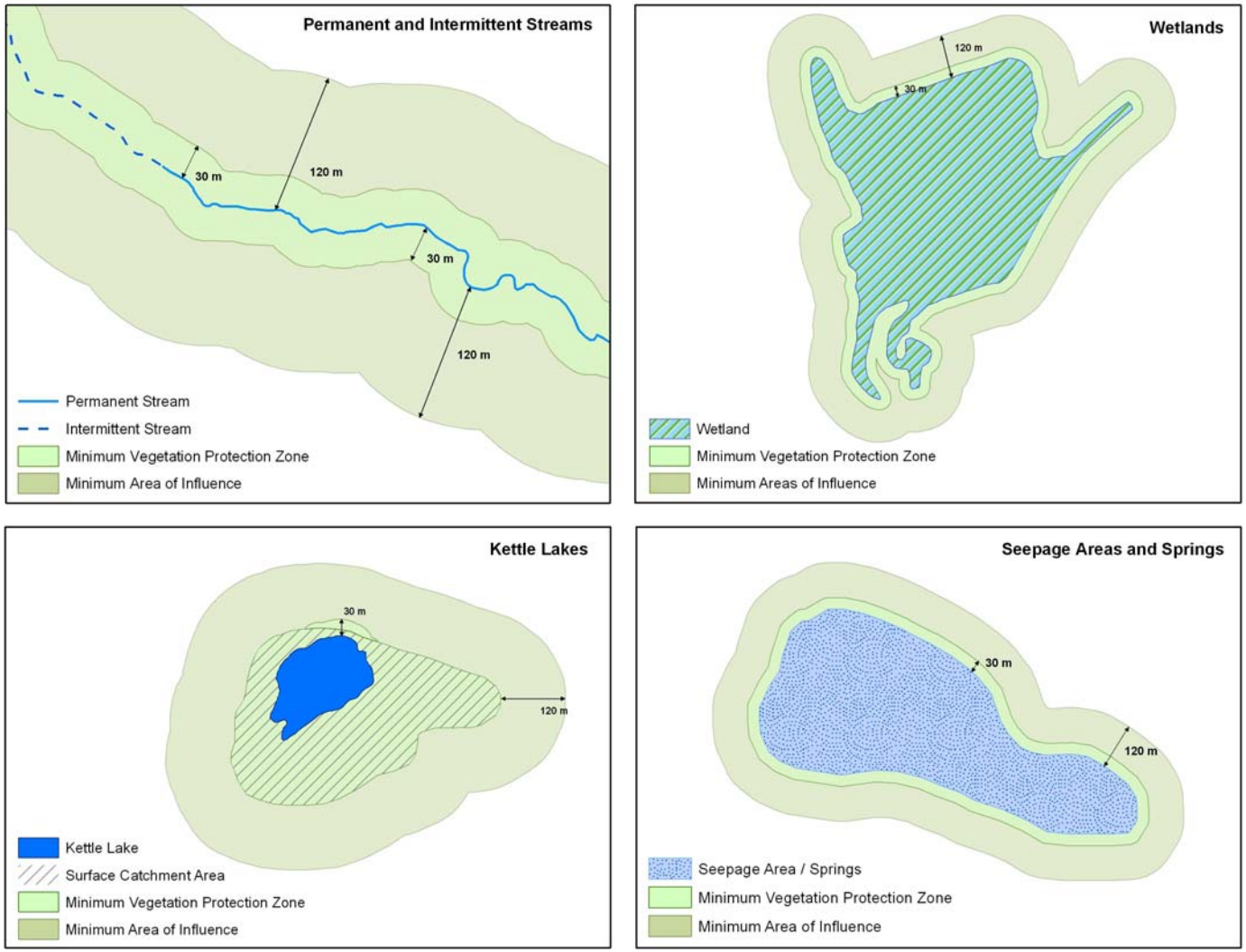
- All development and site alteration proposals occurring within the minimum area of influence of a hydrologically sensitive feature, and
- All types of activities identified in Section 26(2) of the ORMCP within a hydrologically sensitive feature or associated minimum vegetation protection zone (VPZ). For these activities, hydrological evaluations should: focus on best approaches to minimize alteration to the hydrologically sensitive feature and its minimum VPZ, use environmentally friendly standards and approaches, and focus the requirements for setting best engineering methods standards.

Figure 2 shows the minimum areas of influence and minimum vegetation protection zones for various hydrologically sensitive features.

5.2 Procedure for Identifying Hydrologically Sensitive Features

The identification of the presence and extent of any hydrologically sensitive feature is a prerequisite to any application. Identification descriptions are provided in Appendix 1. The assessment for a proposed development site should extend a minimum of 120 metres from the site to determine if the site is within the minimum area of influence of any hydrologically sensitive features.

Figure 2 Diagrams illustrating Minimum Areas of Influence and Minimum Vegetation Protection Zones for Hydrologically Sensitive Features: permanent and intermittent streams, wetlands, kettle lakes, seepage areas and springs



Minimum Areas of Influence and Minimum Vegetation Protection Zones for Hydrologically Sensitive Features

5.3 Development of a Hydrological Evaluation

The Hydrological Evaluation should include the following components in assessing the impacts of the proposed development or site alteration:

Step 1. Determine existing policy and regulatory limitations

The area watershed plan, the ORMCP, regional and municipal Official Plans, and By-Laws should be consulted to determine any planning limitations that may affect the evaluation.

Step 2. Conduct Preliminary Analysis

- Identify the proposed development or site alteration location.
- Research available information, such as topographic maps (1:5,000 scale or 1:10,000), aerial photos, land use maps, municipal studies, watershed plans, wells maps and studies, environmental assessments, and/or environmental impact studies.
- Check any existing mapping available from the Ministry of Natural Resources, or other source, which identifies known Hydrologically Sensitive Features.
- Prepare a site development review to identify:
    - The area that will be replaced with an impermeable surface;
    - The area where soil compaction will occur;
    - The area where vegetation will be removed;
    - Vegetative cover pre- and post-development (using Ecological Land Classification in the classification of the vegetation type.);
    - Predicted use of water resources.
- Describe and characterize pre- and post- (predicted) development water regime;
- Describe significant changes to the water regime that would be generated by the proposed development, including:
    - Increase/decrease in runoff (amount and rate);
    - Redirection of runoff;
    - Increase/decrease in sedimentation;
    - Changes in water quality (surface and groundwater);
    - Change in water temperature;
    - Change in recharge capacity of the site;
    - Water uses that will be part of the proposed development and associated impacts on baseflow, surface storage, and groundwater table.

Step 3. Identify and confirm extent of features

Using field techniques identified in Appendix 1, confirm the location of all hydrologically sensitive features and associated minimum vegetation protection zones and minimum areas of influence. These should be mapped on aerial photos and 1:10,000 scale base maps.

Step 4. Conduct Field Evaluation

Detailed studies should be completed for hydrologically sensitive features in order to describe the hydrologic function and sensitivity of ecosystem features. These studies should include fieldwork in order to assess the relationship of the feature to the hydrologic system.

The evaluation should focus on the nature of the interaction between the groundwater system and the surface water system and the associated sensitivity of the ecosystem within the spatial extent of the area of investigation. This may involve sampling the underlying aquifer(s), surface water bodies, and a number of environmentally sensitive areas. The scale of the study should include the catchment area providing both baseflow and surface water input to the natural features and may therefore extend beyond the Minimum Area of Influence in some cases.

The field study shall assist in understanding the ecological linkages. An all-season sampling study should be implemented for a minimum period of one year, so that baseline data will reflect seasonal variations in water levels and within the ecosystem. The data can then be extrapolated to assess stress subsequent to the proposed development. Semi-monthly to monthly sampling is commonly used to establish a baseline; however, depending on the sensitivity of the area of interest, the frequency and duration of baseline data collection may need to be increased.

The evaluation should examine the effect of the proposed development and site alteration on the size, diversity, health, connectivity, functionality and resilience of the Hydrologically Sensitive Feature. The assessment should examine potential adverse effects generated before, during, and after construction. Although the assessments of impacts should be quantitative, there are some situations where this is not possible. Impacts may be direct and measurable (e.g. removal of vegetation cover) or indirect (e.g. long-term effects to the ecosystem). However, all impacts should be duly assessed. At a minimum, the following should be considered in assessing potential impacts:

- The spatial extent, magnitude, frequency and duration of the impacts;
- The extent and degree to which adjacent lands will be affected;
- Whether the impacts are likely to result in cumulative impacts;
- Potential impacts on specific Hydrologically Sensitive Features and their functions;
- Whether impacts on Hydrologically Sensitive Features are likely to result in impacts on Key Natural Heritage Features.

- Immediate and long-term impacts on connectivity

In addition, the assessment should indicate whether the minimum VPZ is sufficient. In this respect, the evaluation of the nature of the anticipated impacts and whether their extent is likely to exceed the minimum VPZ is necessary. To confirm if the VPZ is sufficient, an assessment should be made based on the comparison of the monitoring data collected before and during construction within and beyond the development area (see Step 7).

Step 5. Identify Mitigation Techniques

The hydrological evaluation should identify specific design, construction and maintenance measures that will be taken to protect the hydrologically sensitive features and associated vegetation protection zones. Appendix 2 lists various potential impacts and mitigation techniques. The evaluation should describe specific mitigation measures that will be implemented to address any negative impacts associated with changes to the water regime. The approval authority may require contingency measures during the construction phase (e.g. Erosion and Sediment Control).

Step 6. Review by the approval authority

In partial completion of an application, the applicant will submit the Hydrological Evaluation to the appropriate municipal planning authority for review and approval. The planning authority will review the evaluation to determine if it is acceptable.

The planning authority may request that further information be provided or alternative mitigation measures and monitoring be considered. For most cases, the hydrological evaluation will not be able to include a complete series of pre-development to post-development monitoring data since permission to proceed with construction has not yet been granted. Specific contingency measures will need to be outlined in the application should pre- to post-development monitoring indicate a problem.

Such conditions can be formalized through various land use planning and approval instruments, including, but not limited to, a site plan agreement between the municipality and the proponent.

Step 7. Implementation and Monitoring

Figure 3 shows a suggested hierarchy of monitoring related to the water provisions of the ORMCP. The scope of monitoring will vary for each program or project based on the requirements of the ORMCP, environmental targets identified in a plan, and specific conditions of an approval.

It is suggested that details of the monitoring to be undertaken, such as the frequency at which samples will be collected or observations made, the locations to be monitored, the methods to be used, and the duration of monitoring be designed to suit the specific needs of the particular program or project.

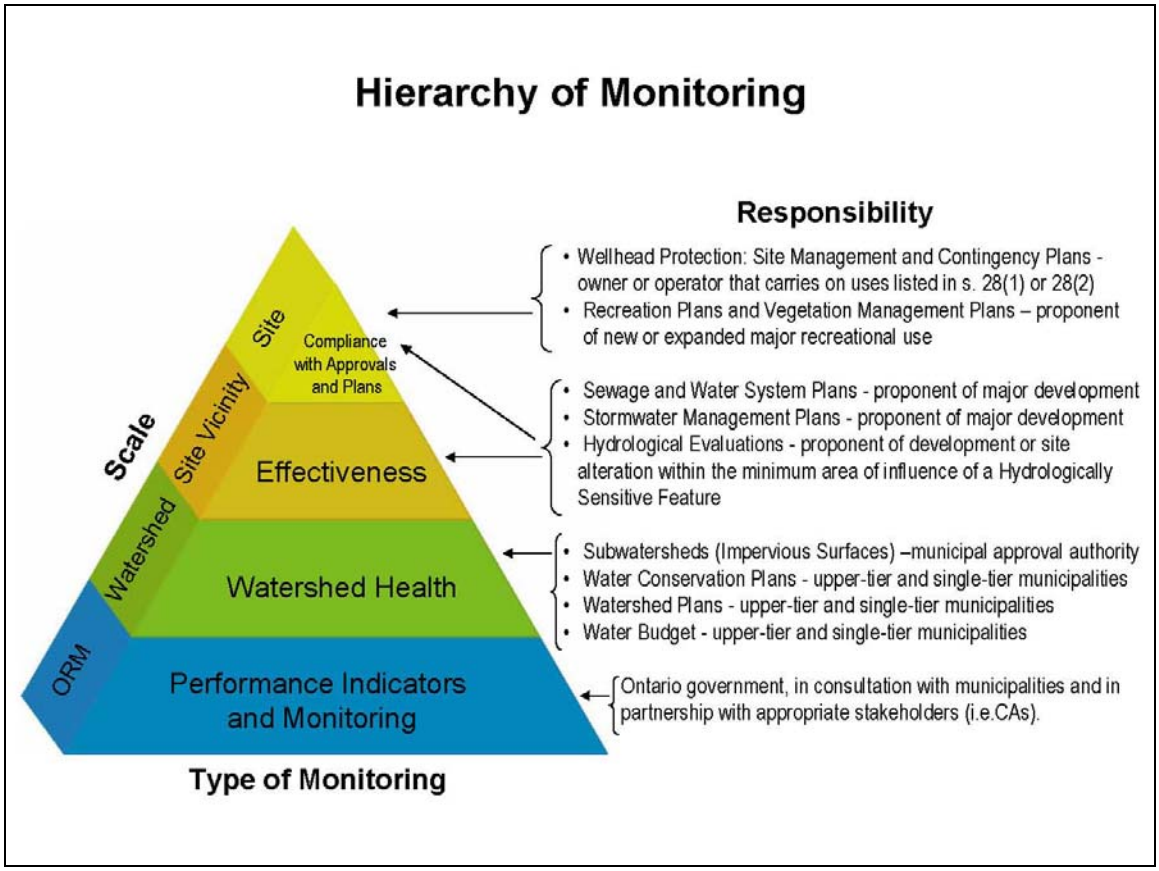
The Ontario government, in consultation with municipalities, shall over time identify performance indicators for monitoring the effectiveness of the ORMCP

(see the Implementation section of the ORMCP). The Province, in partnership with appropriate stakeholders, shall establish a monitoring network to collect, summarize, and evaluate performance indicator data to:

- assess changes in the ecological integrity of the Moraine;
- assess the effectiveness of the policies of the Plan in achieving the Plan's vision and objectives;
- help identify improvements that would address problems encountered in implementing the Plan.

In addition to satisfying the needs of local watershed plans or specific projects, monitoring at the other scales (i.e. at the site, site vicinity, and watershed scales) may provide valuable information that will contribute to the overall monitoring of the ORMCP.

Figure 3 Hierarchy of monitoring related to the water provisions of the ORMCP



It is suggested that proponents of development or site alteration within the minimum area of influence of a hydrologically sensitive feature include in their Hydrological Evaluations an outline of proposed monitoring to be undertaken during and after development or site alteration, as appropriate.

Although it is not specified as a requirement in the ORMCP, monitoring of hydrologically sensitive features located within the site or site vicinity is suggested to:

- demonstrate that the development or site alteration has had no adverse effects on the hydrologically sensitive feature or on the related hydrological functions;
- determine the adequacy of the planning, design, and construction practices at maintaining, and where possible improving or restoring, the health, diversity, and size of the hydrologically sensitive feature; and
- determine whether the minimum vegetation protection zone is sufficient.

It is suggested that details of proposed monitoring, including who will take responsibility for monitoring during and after development or site alteration be included in the Hydrological Evaluation. The proponent of the development or site alteration may be required to conduct monitoring as a condition of site plan approval.

6 References and Resources

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Appendix 1 Definitions and identification of Hydrologically Sensitive Features

	Definition	Identification Regional Scale	Identification Site Scale
Seepage Areas and Springs	• Sites of emergence of groundwater where the water table is present at the ground surface. • Seepage areas are defined as areas where groundwater emerges from the ground over a diffuse area. • Springs are defined as points of natural, concentrated discharge of groundwater.	• Topographic, drainage, and wetland digital map layers provided by the Province (MNR); • Regional groundwater studies that show likely areas of groundwater discharge (e.g. maps of discharge areas and potential discharge areas); • Vegetation maps showing characteristic "wet site" indicator plant species; and • Aerial thermography	• Site-scale topographic surveys, groundwater investigations, or vegetation • Follow all watercourses to their sources. It is preferable to undertake this survey at a time of year when the water table is high, normally the spring, to ensure that intermittent seepage areas and springs are identified. • Identify areas with vegetation indicative of wet areas - these areas indicate that the water table may be close to ground surface and are likely locations of seepage areas or springs. • Identify areas with red or rust coloured, stains on the soil surface these are usually precipitates of iron hydroxides indicating areas of groundwater discharge. • Locate patches of ground that are free of ice and snow in winter - these may indicate locations of seepage areas and springs.
Permanent Streams	A stream which continually flows in an average year.	• Digital map layers. The locations and extent of these features will need to be verified in the field.	Every application requires site verification.
Wetlands	Swamp, marsh, bog or fen (not including land that is being used for agricultural purposes and no longer exhibits wetland characteristics) that: a) is seasonally or permanently covered by shallow water or has the water table close to or at the surface. b) Has hydric soils and vegetation dominated by hydrophylic or water-tolerant plants; and c) Has been further identified by the Ministry of Natural Resources or	• Digital map layers. The locations and extent of these features will need to be verified in the field.	Site specific evaluation to be undertaken to define the outer edge of the wetland using MNR's Ontario *Wetland Evaluation System* (OWES) or Ecological Land Classification for Southern Ontario, both of which currently rely on the OWES criteria for distinguishing between wetland and upland areas. Wetlands with surface areas of less than 0.5 ha are not considered to provide significant hydrological functions and are therefore not classified as Hydrologically Sensitive Features (HSF), where it can be

	Definition	Identification Regional Scale	Identification Site Scale
	by any other person, according to evaluation procedures established by the Ministry of Natural Resources		demonstrated by a qualified person to the satisfaction of the approval authority that the wetland does not constitute or provide one or more of the following features or functions: • a wetland feature having one or more of the following characteristics; o permanent or intermittent surface water connection between the wetland and an adjacent key hydrologic feature; o significant recharge to the underlying aquifer (generally considered to be any small wetland underlain by at least 3 metres of mineral soil having a hydraulic conductivity of 10^{-4}cm/s or more); or o direct hydraulic connections between the wetland and an underlying aquifer (e.g. along fracture zones or granular soil conduits); The above criteria may also be used to help identify those wetlands that are Key Natural Heritage Features as identified in Section 26 of the ORMCP.
Kettle Lakes	• Depression formed by glacial action and permanently filled with water	• Digital map layers. All 32 kettle lakes have been identified by the province. The locations of these features may need to be verified in the field. • Note that the Minimum Vegetation Zone is defined as all land within the surface catchment area or within 30 m of any part of the feature, whichever is greater. The Minimum Zone of Influence is defined as all land within 120 m of the surface catchment area.	Delineate the surface catchment areas by topographic surveys.

	Definition	Identification Regional Scale	Identification Site Scale
Intermittent Streams	• Watercourses that contain water and are dry at times of the year that are more or less predictable. They generally flow during wet seasons of the year but not the entire year. • The water table is above the stream bottom during parts of the year • Intermittent streams are distinguished from ephemeral or episodic streams, which contain water on a more or less unpredictable basis. • Ephemeral streams generally flow only during and for short periods following precipitation or snow melt and flow in low areas that may or may not have well-defined channels. Their stream bottoms are usually above the water table.	• Topographic and drainage digital map layers provided by the Province (MNR).	• Walk and investigate carefully any drainage channels that exist upstream beyond the areas containing flowing water. It is preferable to undertake this survey at a time of year when the water table is high, normally the spring, to ensure that intermittent streams are identified. • In the absence of observable water, the following may be indicative of an intermittent stream: ▪ Streambed material that differs from the surface of the ground surrounding the stream, e.g. recent accumulations of silt, sand, cobble, or gravel in the streambed; ▪ Ridges of sand or silt deposited roughly parallel to the stream on its flood plain; ▪ Presence of seepage areas, springs, or a high water table near the stream channel; ▪ Presence in or near the stream channel of wetland plants, attached algae, clam or mussel shells, crayfish chimneys or exoskeletons, or aquatic insect larvae; ▪ Sediments deposited on top of plants or plant debris in the streambed; ▪ Absence of leaf litter in the streambed; ▪ Accumulations of debris, such as leaves, twigs or litter, on the upstream side of obstructions in the stream channel; and ▪ Presence of hydric soils in the streambed.

Appendix 2 Potential Impacts and Mitigation Techniques

Development Activity	Potential Physical Impacts	Potential Impacts on Functions and Features	Examples of Some Possible Mitigation and Avoidance Techniques
Site Preparation and Servicing			
1. Vegetation Removal **A. <u>Shoreline and Riparian areas</u>** • Clearing • Grubbing	• Loss of shade may result in increased water temperatures • Reduced bank stability and ability to trap sediment from upland areas; increased erosion, sedimentation and turbidity • Reduced stability of sensitive landforms; • increased erosion of landform		
<u>B. Upland Areas</u> • Clearing • Grubbing	• Loss of linkages and corridors for animal movement • Reduced stability of landforms composed of unconsolidated material (esker, moraine, dune, etc.)		
2. Grading	• Increased erosion, sedimentation, and turbidity; increased inputs of nutrients and contaminants to water bodies and wetlands • Changes in natural drainage, including elimination of streams, increased or decreased surface runoff; increased or decreased streamflows • Changes in soil moisture and species composition of vegetation • Alteration or destruction of landforms composed of unconsolidated materials (e.g. kames, eskers, sand dunes)	• Decreased photosynthesis, loss of productivity, loss of fish habitat, loss of food organisms, avoidance by fish, lethal or sub-lethal toxic effects on aquatic life; changes in fish composition and abundance; changes in wetland plant communities • Loss of fish habitat (e.g. water, spawning areas), loss of food organisms; changes in fish species composition and abundance; changes in wetland plant communities, channel erosion, change in geomorphology • Loss of important wildlife species or habitat • Loss of Earth Science ANSI, valleyland, etc.	• Maintain vegetative buffers; develop and implement an erosion and sediment control plan; control access and movement of equipment; time activities to avoid sensitive periods of habitat use (e.g. spawning); schedule to minimize area and duration of soil exposure • Minimize changes in land contours and natural drainage; maintain streams (permanent and intermittent), and timing and quantity of flows • Minimize vegetation removal and changes in land contours, and natural drainage-sensitive species • Avoid grading of areas containing significant landform features

Development Activity	Potential Physical Impacts	Potential Impacts on Functions and Features	Examples of Some Possible Mitigation and Avoidance Techniques
3. Aggregate Extraction	• Alteration or removal of landforms • Increased erosion, sedimentation and turbidity to water bodies and wetlands • Changes in natural drainage, including altered surface runoff; altered streamflows • Changes in soil moisture and species composition of vegetation • Increased groundwater recharge. • Creation of Wetlands • Creation of Habitat	• Alteration of subsurface flow regime • Decreased photosynthesis, loss of productivity, loss of fish habitat, loss of food organisms, avoidance by fish, lethal or sub-lethal toxic effects on aquatic life; changes in fish species compositions and abundance; changes in wetland plant communities • Loss of important wildlife species or habitat	• Minimize extraction in sensitive head water areas • Maintain vegetative buffers; develop an erosion and sediment control plan; control access and movement of equipment; time activities to avoid sensitive periods of habitat use (e.g. spawning); schedule to minimize area and duration of soil exposure • Minimize vegetation removal
4. Installation of Services and Utilities (e.g. water sewers, hydro, stormwater management facilities)	• Increased erosion, sedimentation, turbidity; increased inputs of nutrients and contaminants to water bodies • Hydrological changes (e.g. changes in water levels as a result of re-routed water flow)	• Decreased photosynthesis, loss of productivity, loss of fish habitat, loss of food organisms, avoidance by fish; changes in fish species composition and abundance • Changes in vegetative communities and fish and wildlife assemblages; reduction in groundwater recharge	• Maintain vegetative buffers; develop and implement an erosion and sediment control plan; time activities to avoid sensitive periods of habitat use; re-establish vegetation as soon as possible • Conduct appropriate studies to determine how to maintain existing hydrological regime; design underground facilities to minimize impacts on groundwater flows (seepage collars, orientation and depth of trenches, etc.)

Development Activity	Potential Physical Impacts	Potential Impacts on Functions and Features	Examples of Some Possible Mitigation and Avoidance Techniques
Construction			
1. Building Construction	• Increased erosion, sedimentation and turbidity; increased inputs of nutrients to water bodies and wetlands • Water contamination by oils, gasoline, grease and other materials • Increase in impervious surfaces; increased surface runoff, reduced infiltration and groundwater discharge; reduced stream base-flows and upwelling; loss of vegetation resulting in increased water temperatures	• Decreased photosynthesis, changes in productivity, loss of fish habitat, loss of food organisms, avoidance by fish; changes in fish species composition and abundance; loss of stream and channel stability; changes in plant communities • Lethal or sub-lethal toxic effects on aquatic life and vegetation • Loss of fish habitat (e.g. water, spawning areas for brook trout); changes in fish species composition and abundance; changes in wetland vegetation communities; drying of wetlands	• Maintain vegetative buffers; control erosion, sedimentation and nutrient inputs through use of Best Management Practices (BMPs) • Control Water Contamination through BMPs • Maintain or provide vegetative buffers; control quantity and quality of storm water discharge using BMPs
2. Water Crossings (roads)	• Realignment of stream channel; changes in water velocity • Increased erosion, sedimentation and turbidity • Impediment of lateral flows in wetlands • Pollutants from road	• Barrier to fish movement may be created; may create downstream erosion or sediment deposition; separation of stream from floodplain • Decreased photosynthesis, changes in productivity, loss of fish habitat, loss of food organisms, avoidance by fish; changes in fish species composition and abundance; changes in wetland vegetation • Significant alterations in wetland vegetation communities; potential change of wildlife type; changes in wildlife populations • Heavy metals, oils and grease from vehicles	• Maintain existing stream channel; use bridges to span stream; time construction to avoid sensitive periods of habitat use (e.g. spawning) • Minimize width of right-of-way; develop and implement an erosion and sediment control plan • Install adequate culverts and gravel base to maintain flow of surface water and shallow groundwater • Collect and treat road runoff in storm water management facilities
3. Paving	• Increase in impervious surfaces; increased surface runoff and stream peak flows; reduced infiltration, base-flows and upwellings • Increased erosion, sedimentation and turbidity from increased peak flows; increased inputs of nutrients and contaminants to water bodies and wetlands • Increased water temperatures	• Loss of fish habitat (e.g. water upwelling/spawning areas for brook trout); changes in fish species composition and abundance; changes in wetland vegetation communities • Loss of fish habitat; lethal or sub-lethal toxic effects on aquatic life; changes in wetland vegetation communities and productivity • Loss of cold and cool water fish species, where water temperatures exceed their tolerances.	• Minimize area of paved surfaces; design roads without curbs, gutters and sidewalks to promote infiltration; maintain or provide vegetative buffers; control quantity and quality of storm water using BMPs

Development Activity	Potential Physical Impacts	Potential Impacts on Functions and Features	Examples of Some Possible Mitigation and Avoidance Techniques
Activities Associated with Development			
1. Groundwater Taking	• Reduced groundwater discharge; reduced stream base-flows and upwelling; increased water temperature	• Loss of fish habitat (e.g. water, spawning areas); changes in fish species composition and abundance; changes in wetland hydrology and vegetation communities • Loss of moisture-sensitive vegetation communities and species which depend on them	• Control the rate and timing of water pumping; implement controls on lawn watering; pump from deep wells to infiltration galleries adjacent to water bodies or wetlands
2. Use of Septic Systems	• Increased inputs of nutrients and contaminants to water bodies and wetlands; increased algal growth, reduced oxygen levels • Faulty systems may adversely affect vegetation	• Loss of fish habitat (e.g. reduced oxygen in deep portions of lake trout lakes); lethal or sub-lethal toxic effects on aquatic life; changes in fish species composition and abundance; changes in wetland vegetation communities and productivity; loss of waterfowl species • Loss of vegetation can de-stabilize vegetation or landforms	• Make alternative servicing arrangements or use alternative nutrient removal technologies • Avoid installing system near sensitive vegetation or landforms
3. Human Occupation	• Increased inputs of nutrients and contaminants to water bodies and wetlands from use of fertilizers, pesticides, etc.	• Increased productivity, increased algal growth, reduced oxygen levels; lethal or sub-lethal toxic effects on aquatic life and wildlife species	• Avoid use of fertilizers and other chemicals in shoreline or riparian areas; maintain or provide vegetative buffers