

cover, and ecopassages to permit the passage of sensitive wildlife weher linkages intersect with road infrastructure.

- iv) Provision of other linkages using complementary land uses (such as major utility corridors, parks, school campuses, other institutional uses), as well as retained or new linkage elements such as hedgerows;
- v) Enhancement of features and functions as mandated by the PPS; these are dependent on the adoption and effective implementation of local policies (Region, Town, and other approving agencies) in concert with the cooperation and flexibility of development proponents and other private stakeholders in the subwatershed.
- vi) Monitoring and adaptive management of the future urban NHS. This will require regular review of conditions in the NHS, identification of areas which are being degraded, and identify approaches to restore and maintain integrity.

Due to the existing level of habitat fragmentation in the study area, the degree to which identified opportunities are supported and implemented, will largely determine whether a sustainable Natural Heritage System can be achieved. The Secondary Planning of the Derry Green, Boyne Survey and Education Village lands will target an overall 'net gain' principle, in terms of protection of natural cover and enhancement of functions over existing conditions. Some cumulative change to habitat quality and functions is considered largely inevitable as the future development areas are converted from rural to urban uses.

8. IMPLEMENTATION PLAN

The implementation plan provided in the January 2000 Subwatershed Planning Study was developed to specifically address the requirements of the Phase 1 Area. Nevertheless, the Subwatershed Planning Study provided an overview of guiding principles which should be applied in the development of implementation plans in support of the Secondary Planning Process for future development areas. Subsequent to the January 2000 Subwatershed Planning Study, these principles have subsequently been applied for the Highway 401/Industrial Business Park Functional Stormwater and Environmental Management Strategy (Philips Engineering Ltd., July 2000) as well as the Indian Creek/Sixteen Mile Creek Sherwood Survey Subwatershed Management Study (Philips Engineering Ltd., December 2004). These guiding principles have been refined as part of the Subwatershed Update Study, based upon comments provided by the Steering Committee.

In general, implementation plans are required to provide specifics associated with the implementation of the overall requirements of the Subwatershed Plan:

- (i) Phasing
- (ii) Financing/Cost Sharing
- (iii) Operations and Maintenance
- (iv) Monitoring and Adaptive Management
- (v) Terms of Reference for Future Studies
- (vi) Fisheries Compensation Plans
- (vii) Watershed Plan Checklist

The following section provides an overview of the principles which are to be applied in the development of the above components of the implementation plans which are to be defined as part of subsequent studies (i.e. FSEMS's).

8.1 Phasing

As indicated in January 2000 Subwatershed Planning Study, the purpose of the Phasing Plan is to identify inter-development timing dependencies for construction of stormwater and environmental management infrastructure which would serve to:

- Minimize overall cost.
- Minimize environmental impacts due to repeated construction disturbance.
- Minimize requirements for temporary works.
- Avoid liability associated with impacts of out-of-phase works.

Typically, the sequence for implementing new development is not compatible with the timing and need for major infrastructure projects, particularly for drainage works. The January 2000 Subwatershed Planning Study established the following Subwatershed-wide phasing principles, which have been applied for all developing lands within Milton's Urban Expansion Areas:

- i) *Development Phasing by Local Drainage Areas:* There is significant benefit to grouping phases based on/having regard for the ultimate drainage patterns. This may be best identified at the time of Subwatershed Impact Studies.
- ii) *All Developments, Regardless of Timing, Require Stormwater Management:* Stormwater management facility construction is to be completed in conjunction with development to meet quality and quantity control objectives.
- iii) *Downstream to Upstream Staging Philosophy is Preferred:* For stormwater infrastructure where topography is flat and there is minimal depth for storm servicing, there is an advantage to development proceeding from downstream limit to upstream.
- iv) *Geographic Distance from Communal Facilities can Influence Staging and Need for Interim Works:* Where topography is not a significant constraint, the distance to facilities becomes the primary consideration.
- v) *Phasing of Communal Infrastructure is Possible:* Communal stormwater management facilities can be constructed in phases.
- vi) *Conveyance Systems Need to be Designed to Ultimate Capacity:* Trunk storm sewers should be constructed to ultimate capacity.

8.2 Financing/Cost Sharing

As indicated in the January 2000 Subwatershed Planning Study, the purpose of the financing/cost sharing plan is to:

- Identify and evaluate alternative models for financing and cost sharing for capital and program works.
- Evaluate and select methods of cost apportionment for capital and program works.

The preferred solution would outline the approach to be applied for the financing and cost sharing of:

- i) flood control works (watercourse and culvert improvements, stormwater management storage facilities),
- ii) erosion control (extended detention in stormwater management facilities and watercourse improvements),
- iii) water quality (extended detention stormwater management facilities),
- iv) servicing (watercourse lowering), and
- v) system/subwatershed management guidelines.

Of the foregoing, it is inferred that the system/subwatershed management guidelines will apply to all development proponents in a uniform, unbiased manner. The remaining works all relate to specific undertakings which will be required prior to, or in conjunction with, development of the respective development area. As such, the following philosophy, originally advanced as part of the January 2000 Subwatershed Planning Study, has been established as a basis for cost-sharing formulation:

Where stormwater works are recommended which can be considered to benefit multiple property owners (i.e. communal), the lands within the benefitting area will be responsible in proportion to total impervious coverage. All other works which would be of benefit to the local landowner, would be wholly attributable to that landowner.

The January 2000 Subwatershed Planning Study identified various legislative vehicles to implement the specific Subwatershed Management Strategy for development areas. Depending upon the will of the potentially affected landowners, as well as Municipal Council, there may be a preference toward one particular legislative vehicle. While the selection of the preferred approach is considered beyond the scope of any Subwatershed or Secondary Planning Study, it is nevertheless recognized that a landowner financial agreement is required by the Town.

8.3 Operations and Maintenance Plan

The purpose of the Operations and Maintenance Plan is to develop a plan for effective and efficient operation and maintenance of all infrastructure and environmental systems recommended through the Subwatershed Management Plan. The Subwatershed Management Strategy for each development area provides recommendations for various component elements of the Municipal infrastructure, which, once constructed, will need to be operated and maintained by the Municipality in order to preserve its intended function. Specific infrastructure components requiring operation and maintenance include:

- Stormwater management facilities
- Trunk storm sewers
- Open watercourse systems
- Hydraulic structures (culverts and bridges)
- Natural heritage systems)

The specific maintenance requirements of each component element depend upon the type of infrastructure constructed; these details are beyond the scope of the current Subwatershed Update Study, and are to be established as part of future FSEMS's to be completed in support of the Secondary Planning processes for the development areas.

8.4 Monitoring and Adaptive Management Plan

The purposes of monitoring plans and adaptive management plans, respectively, are to:

- Develop mechanisms through which the performance of the Subwatershed Management Plan recommendations may be evaluated with respect to overall subwatershed and watershed goals, and
- Develop mechanisms to adjust and/or optimize the Subwatershed Management Plan and associated recommendations, based on results of monitoring and future advances in resource management.

The monitoring plans are integrated with the Conceptual Fisheries Compensation Plan as part of the Fisheries Act authorization for the project, and is subject to approval by the approval agencies. These details are developed as part of the FSEMS studies in support of the Secondary Planning Studies for the development areas, and are beyond the scope of the current Subwatershed Update Study. Nevertheless, it should be recognized that the monitoring and adaptive management plans are required to evaluate the natural heritage systems, fisheries, hydrogeology, stormwater management, and fluvial geomorphologic components of the Subwatershed Management Strategy developed for the respective drainage area.

The collection of field data from similar sites over an extended period of time can provide great insight on channel processes and function. This monitoring can also yield information regarding the response of a channel to changes in upstream land use. Typically, these responses take the form of planform adjustment, bank erosion, changes in cross-sectional area and changes in substrate composition. These adjustments can, in turn, affect aquatic habitat and water quality.

Future work from a geomorphic perspective should consist of two components: long-term monitoring of existing control stations and additional geomorphic field work to confirm appropriate and relevant erosion thresholds on a more site-specific basis for proposed development. Long-term monitoring would entail the repetition of baseline efforts undertaken through this study, whereby control cross-sections, substrate composition and erosion pins would be re-measured on an annual basis at a similar time of year and documented through photographic record. A fluvial geomorphologist should be used to interpret the findings and assess whether substantial change has occurred and to recommend any potential mitigative efforts. Additional detailed geomorphic field work would remain consistent with efforts documented through this study (10 cross-sections, substrate composition, bank properties and longitudinal survey) at the most sensitive downstream reach to be impacted by proposed land use modifications in order to establish the governing threshold for that drainage system.

Groundwater Monitoring

Throughout the course of the Subwatershed Update Study, it has been recognized that groundwater monitoring previously recommended as part of the January 2000 Subwatershed Planning Study and advanced as part of the SIS's completed for the various development areas, has not been implemented accordingly. During the course of the Subwatershed Update Study,

the absence of this information has been identified as a significant data gap, despite the current significance ascribed to maintaining our groundwater resources.

Site specific groundwater studies are recommended to be implemented in order to confirm the more local hydrogeologic setting and its functional relationship to the other ecosystem components. Generic guidelines for these studies can be found in Appendix 'C'. These studies should incorporate the site specific data into the more regional characterization to assess potential impacts and mitigation. It is critical that a representative number of monitoring wells and baseflow measurement locations (i.e. where baseflow exists and is functionally important) be carried forward to assess the potential impacts on the local groundwater quantity and quality, compare it to natural trends and assess the performance of any mitigative practices.

The groundwater monitoring program is designed to consider the potential impacts from a reduction in groundwater recharge and the potential for degraded stormwater infiltrating into the groundwater system.

As major developments proceed, shallow piezometers would normally be installed to confirm the water table. A number of piezometers should remain in each major development area. These piezometers should be cased and locked for security. Water levels and water chemistry should be monitored at least on a two to five year schedule depending on the local hydrogeologic sensitivity and the ongoing trends. The schedule is also dependent to a large degree on the pace of development. Chemical analysis should include inorganic parameters, nitrogen species, and metals. Water level trends correlated to rainfall are necessary to assess changes on the recharge resulting from development.

Spot baseflow measurements will give an indication of changes in groundwater discharge to the local watercourses and long with water levels provide data to assess changes in recharge. Groundwater discharge areas within the streams can vary over time due to the stream dynamics. It is important to correlate the spot baseflow measurements with the continuous stream flow measurements. It is recommended that water quality and temperature measurements be taken at a number of spot baseflow locations. The spot baseflow measurements are to be taken during periods when only groundwater is expected to be providing flow to the stream such as in between rainfall events, or subsequent to spring runoff.

8.5 Terms of Reference for Future Studies

Future developments of lands within the Sixteen Mile Creek Watershed will need to address the directives provided in the higher level planning documents. Moreover, more locally based and higher resolution studies will be required in order to support local development initiatives; these studies will require an enhanced level of detail at a commensurate with the level of detail associated with the site-specific analyses. Specifically, the following studies are to be completed, in the sequence provided:

- Functional Stormwater and Environmental Management Strategies
- Subwatershed Impact Studies and Environmental Impact Studies/Assessments
- Stormwater Management Plan (Functional Design)
- Stormwater Management Plan (Detailed Design)

Functional Stormwater and Environmental Management Strategies

As indicated previously within this study, the Functional Stormwater and Environmental Management Strategy is implemented in support of the Secondary Planning of development areas within the Town of Milton. These studies are intended to build upon the baseline information and constraint mapping provided within the current document, and to provide detailed recommendations for the systems required to manage the environmental systems within the development areas, in accordance with current Federal, Provincial, Regional, and Municipal policies, legislation, and guidelines. Specific recommendations provided within these studies include:

- Detailed impact assessment of proposed development
- Stormwater management requirements
- Watercourse and hydraulic structure requirements
- Natural heritage system for development area
- Conceptual Fisheries Compensation Plan
- Development areas to be assessed collectively under specific Subwatershed Impact Studies

The NHS Approach to be applied under each FSEMS for each of the detailed SUS Study Areas will include the following:

- Consider regional scale NHS goals and objectives (Greenbelt, Niagara Escarpment Plan, Sustainable Halton)
- Protect and enhance existing Significant features, including habitats of species of concern.
- Integrate multi-disciplinary ratings of streams to prioritize key corridors and potential linkages based on water features; identify other linkage opportunities where watercourses cannot provide adequate linkages.
- Identify features & areas to restore and diversify to achieve long-term functional viability
- Apply buffers to significant features and corridors to maintain integrity and species diversity; set minimum buffer standards in FSEMS
- Integrate with infrastructure elements (SWM areas, wildlife eco-passages) and complementary land uses (Parks, school campuses, other institutional uses, golf courses,)
- Provide implementation and management guidance
- Develop and apply Adaptive Management Plan

Subwatershed Impact Studies

Requirements for Subwatershed Impact Studies have been previously defined within the January 2000 Subwatershed Planning Study. Subwatershed Impact Studies represent an intermediate level of study, which is required in areas where multiple land ownership within the subwatershed occurs; the limits of these areas are defined during the Secondary Planning process, and are to be advanced as part of the Functional Stormwater and Environmental Management Strategy. This

level of study would focus on integrating servicing and stormwater management of adjacent development to a greater level of detail than is normally achieved through the Subwatershed Plan; the detailed site specific work may identify additional features/functions which were not captured as part of the Subwatershed Study, which should be evaluated using the same criteria as established in the Subwatershed Study. The objectives of this level of study are to determine:

- Identify the opportunities and constraints to development at a site specific level
- Refine the natural heritage and natural hazard limits
- Determine preferred servicing plan
- Determine road layout
- Develop and define integration of stormwater management facilities
- Determine opportunities to integrate recreation opportunities with stormwater management
- Define phasing and cost sharing in areas of multiple ownership
- Validate fisheries mitigation and compensation
- Finalize appropriate terrestrial corridor and woodlot buffer widths

Tertiary plans represent an important component to the SIS process, with respect to features and systems which cross SIS boundaries (i.e. NHS protection, road alignments). As such, the SIS should be developed in support of Tertiary Plans rather than draft plans, in order to provide guidance with respect to the constraints and opportunities associated with connecting features and systems to adjacent SIS areas.

Stormwater Management Plans

Requirements for Stormwater Management Plans have been previously defined within the January 2000 Subwatershed Planning Study. Stormwater Management Plans are prepared in support of individual development applications. The plans complement the planning process associated with Draft Plans of Subdivision or individual Site Plans. Stormwater management reporting associated with this planning stage would be the “Functional Design” plan. Subsequently, in support of final subdivision design, a “Detailed Design” plan is prepared.

Functional Design

This level of design typically involves demonstrating the feasibility of providing stormwater management for a particular development. In areas where no Subwatershed Plan has been completed, the Stormwater Management Plan will be required to address additional issues such as environmental baseline conditions and screening of various stormwater management strategies and techniques. For the Derry Green and Boyne Surveys, the intent of the Functional Design Stormwater Management Plan would focus on demonstrating compatibility and compliance with principles and requirements prescribed in the corresponding Functional Stormwater and Environmental Management Strategies, as well as the specifics emanating from the Subwatershed Impact Study.

Detailed Design

The detailed design submission is required to demonstrate how the required information, outlined in the Functional Design report, has been integrated as well as addressing details related to minor system design details, landscaping, safety, and maintenance aspects of Stormwater Management Facility design, as well as outlining subsequent specific monitoring requirements.

8.6 Conceptual Fisheries Compensation Plan

The Conceptual Fisheries Compensation Plan forms part of the implementation process for the Subwatershed Plan. Component recommendations of the Compensation Plan may be considered for Development Charges contributions by the developing land base, since the impact being compensated for is caused by the development. It is intended that the Conceptual Fisheries Compensation Plan be used, along with the Functional Stormwater and Environmental Strategy, to support individual development applications for DFO authorization.

The objectives of this study are to:

- i) Develop a Conceptual Fisheries Compensation Plan to allow for a holistic assessment and management of cumulative fish habitat impacts, and mitigation of such impacts throughout the development area.
- ii) Provide design guidelines and submission requirements for future design and permit submissions/applications to the Regulatory Agencies.
- iii) Streamline the review and approval process for applicants and Public agencies.

It should also be re-emphasized that the lowering of streams to facilitate development presents a particular challenge, specifically within the Boyne Survey lands, but also portions of the Derry Green lands as well. Given the minimal existing topography within the study area, any major modifications to stream bed elevations would require substantial grade corrections that could extend beyond the upstream and downstream boundaries of these lands. As such, this issue represents a critical consideration in the implementation of development options.

9. REFERENCES

- Aquafor Beech Limited and C. Portt and Associates, 2005.** Environmental audit of channel works. Bristol Survey, Milton. Unpublished report prepared for the Town of Milton. 39 p plus appendices.
- Badzinski, D.S., R.W. Archer, S.T.A. Timmermans, K.E. Harrison, and K.E. Jones (revised by M. Doyle). 2008.** Assessment of trends in frog and toad populations in Ontario using citizen science monitoring data [electronic resource] / prepared for the Ecological Monitoring and Assessment Network Coordinating Office, Environment Canada.
- Bakowsky, W. D. 1996.** Natural Heritage Resources of Ontario: Vegetation communities of southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario. 21 pp.
- Brooks, A. 1906.** Birds of Halton County, Ontario. *Ontario Natural Science Bulletin* 2: 6-10.
- Brummer, C. J. 2004.** Process controls on bed-surface grain size and the geomorphic response of low-order mountain channels to landsliding following timber harvest, 25th Anniversary Conference, International Society of Wetland Scientists, Seattle, Washington.
- BSC (Bird Studies Canada). 2003.** Marsh Monitoring Program - Training Kit and Instructions for Surveying Marsh Birds, Amphibians and their Habitats. 2003 Edition. 40 pages. Published by Birds Studies Canada in cooperation with Environment Canada and the U.S. Environmental Protection Agency. March 2003.
- Cadman, M.D., P.I.F. Eagles and F.M. Helleiner (Eds.). 1987.** *Atlas of the Breeding Birds of Ontario*. University of Waterloo Press, Waterloo, Ontario. 617pp.
- Cadman, M.D., D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier (eds.) 2007.** *Atlas of the Breeding Birds of Ontario, 2001 – 2005*. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto. xxii + 706 pp.
- Catling, P.M. and V. R. Brownell. 2000.** *Damselflies and Dragonflies (Odonata) of Ontario: Resource Guide and Annotated List*. ProResources, 2336 Srivens Drive, Metcalfe, Ontario, Canada. 200 pp.
- Chapman, L.J., and D.F. Putman. 1984.** *The Physiography of Southern Ontario*. Third Edition. Ontario Ministry of Natural Resources.
- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2007.** Canadian Species at Risk. Committee on the Status of Endangered Wildlife in Canada, September 2007. 84 pp. COSEWIC Web site: http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf

- COSEWIC (Committee on the Status of Endangered Wildlife in Canada). 2008.** COSEWIC Species Assessments from the April 2008 COSEWIC meeting (detailed version)
http://www.cosewic.gc.ca/rpts/Detailed_Species_Assessments_e.pdf
- Coventry, A.F. 1940.** Desiccation Priorities for the Birds of Southern Ontario. 14pp + 38pp Technical Appendices, and Priority species Lists.
- Credit Valley Conservation and Toronto Region Conservation Authority, March 2007.** Interim guidelines for the evaluation, classification and management of headwater drainage features.
- Crins, 1986.** Vascular Plants of the Regional Municipality of Halton. Unpublished list.
- Crins, W.J., W.D. McIlween, A.G. Goodban and P.G. O'Hara. 2006.** The Vascular Plants of Halton Region, Ontario. pp. 1 – 78. *In:* J.K. Dwyer (Ed.) Halton Natural Areas Inventory 2006. Volume 2 – Species Checklists. 184pp.
- Curry, R. 2006.** The Herpetofauna of Halton Region, Ontario. pp. 97 – 112. *In:* J.K. Dwyer (Ed.) Halton Natural Areas Inventory 2006. Volume 2 – Species Checklists. 184pp.
- Curry, R. 2007.** Birds of Hamilton and Surrounding Areas. Robert Curry and the Hamilton Naturalists' Club. 647 pp.
- Dobbyn, S. 1998.** Ontario Mammal Atlas data records.
- Dougan & Associates 2008.** Louis St. Laurent Crossing Terrestrial Resources Impact Analysis.
- Douglas, M.M. and J.M. Douglas. 2005.** Butterflies of the Great Lakes Region. The University of Michigan Press. Ann Arbor, Michigan. 345 pp.
- DuBois, B. 2005.** Damselflies of the North Woods. North Woods Naturalist Series. Published by Kollath-Stensaas Publishing, Duluth, MN. 131 pp.
- Dwyer, J.K. 2006a.** Halton Natural Areas Inventory. 2006: Volume 1 Site Summaries
- Dwyer, J.K. 2006b.** Halton Natural Areas Inventory. 2006: Volume 2 Species Checklists
- Dwyer, J.K. , B.K. Axon, P. Attack, and K.A. Barrett. 2006.** The Mammals of Halton Region, Ontario. pp. 183 – 184. *In:* J.K. Dwyer (Ed.) Halton Natural Areas Inventory 2006. Volume 2 – Species Checklists. 184pp.
- Ecoplans Limited. 1996.** Compendium to Sixteen Mile Creek Watershed Plan. Prepared for Regional Municipality of Halton.
- Geomatics International. 1991.** Addendum Report: Environmentally Sensitive Area Study.

- Geomatics International. 1993.** Environmentally sensitive Areas Study prepared for Regional Municipality of Halton Planning and Development Department.
- Glassbeerg, J. 1999.** Butterflies through Binoculars. The East. A Field Guide to the Butterflies of Eastern North America. Oxford University Press. New York, N.Y. 242 pp.
- Gomi, T., R.C. Sidle and J.S. Richardson. 2002.** Understanding processes and downstream linkages of headwater systems. *BioScience*, 52(10): p. 905-916.
- Halton Region, 2006.** Halton Region Official Plan. 2006.
Available: <http://www.halton.ca/ppw/Planning/OP/ROP.htm>
- Harding, J.M. 1997.** Amphibians and Reptiles of the Great Lakes Region. University of Michigan Press. Ann Arbor, Michigan. 378pp.
- Jones, C. 2007.** Personal communication with Colin Jones, odonate expert and Project Biologist at NHIC on July 20, 2007 to discuss the status of River Bluet (*Enallagma anna*).
- Jones, C.D., A. Kingsley, P. Burke and M. Holder. 2008.** Field Guide to the Dragonflies and Damselflies of Algonquin Provincial Park and the Surrounding Area. The Friends of Algonquin Park. Whitney, Ontario. 263 pp.
- Kavanagh and McKay-Kuja, 1992.** A Classification of the Natural Communities Occurring in Ontario. Draft. Prepared for Carolinian Canada and Great Lakes Data Center Projects.
- Lam, E. 2004.** Damselflies of the Northeast. A guide to the species of eastern Canada & the northeastern United States. Published by Biodiversity Books, Forest Hills, New York. 96 pp.
- Lamond, W.G. 1998.** Site-specific Hamilton Herpetofaunal Atlas database records for Subwatershed Areas 2 and 7. Unpublished and confidential list.
- Layberry, R.A., P.W. Hall and J.D. Lafontaine. 1998.** The Butterflies of Canada. University of Toronto Press, Toronto. 280pp.
- Lee, H.T., W.D. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Ulhig, and S. McMurray. 1998.** Ecological Land Classification for Southern Ontario: First Approximation and its Application. Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.)
- Lee, H.T. 2006.** Draft. Treed Ecosystem Classification for Southern Ontario. Reviewers' copy.
- Leopold, L. B. 1994.** A View of the River. Harvard University Press, Cambridge, Massachusetts.
- LGL Limited, May 28, 2008.** Data Transmittal to Jim Dougan, Dougan & Associates, May 28, 2008. Project TA4666. Milton Phase III Land Secondary Plan. Existing Property

Conditions Summaries and Figures. Prepared by LGL Limited, 3365 Harvester Road, Burlington, Ontario L7N3N2.

- LGL Ltd. 2008a.** Milton Phase Three Lands 2007 & 2008 Field Data (copies of field notes provided to Dougan & Associates). May 28, 2008
- LGL Ltd. 2008b.** Mattamy West Tremaine Natural Heritage Features Fact Sheet. June 2008.
- McIlveen, W.D. 2006.** The Birds of Halton Region, Ontario. pp. 79 – 96. *In:* J.K. Dwyer (Ed.) *Halton Natural Areas Inventory 2006*. Volume 2 – Species Checklists. 184pp.
- Mead, K. 2003.** Dragonflies of the North Woods. North Woods Naturalist Series. Published by Kollath-Stensaas Publishing, Duluth, MN. 203 pp.
- Ministry of Environment, 1999.** Ontario Ministry of Environment. Revised Stormwater Management Guidelines Draft Report.
- Newmaster, S.G., A. Lehela, P.W.C. Uhlig, S. McMurray and M.J. Oldham. 1998.** Ontario Plant List. Ontario Ministry of Natural Resources, Ontario Forest Research Institute, Sault Ste. Marie, Ontario, Forest Research Information Paper No. 123, 550 pp. + appendices.
- NHIC (Natural Heritage Information Centre). 2008a.** Web-based geographic query of the Natural Areas data and Element Occurrence data.
<http://nhic.mnr.gov.on.ca/MNR/nhic/queries/geographic.cfm>
- NHIC (Ontario Natural Heritage Information Centre). 2008b.** Species List for all Provincially-Tracked flora and fauna. Ontario Natural Heritage Information Centre Home Page.
http://nhic.mnr.gov.on.ca/MNR/nhic/species/species_list.cfm
- Nikula, B., J.L. Loose and M.R. Burne. 2003.** A Field Guide to the Dragonflies and Damselflies of Massachusetts. Massachusetts Division of Fisheries & Wildlife. Natural Heritage & Endangered Species Program.
- North-South Environmental Inc., Dougan and Associates, and Sorensen Gravely Lowes. 2008.** Peel-Caledon Significant Woodlands and Significant Wildlife Habitat Study: Draft for Public Comments - October 2008. Ontario: Region of Peel and Town of Caledon.
- North-South Environmental Inc., 2009.** Natural Heritage System Definition & Implementation - Sustainable Halton Report 3.02, prepared for the Region of Halton.
- OBBA (Ontario Breeding Bird Atlas). 2001.** Guide for Participants. Atlas Management Board, Federation of Ontario Naturalists, Don Mills. 34pp.
- Oldham, M. J., Bakowsky, W.D. and D.A. Sutherland. 1995.** Floristic Quality Assessment System for Southern Ontario. Natural Heritage Information Centre, Ontario Ministry of Natural Resources.

- Oldham, M.J. 1999.** Natural Heritage Resources of Ontario: Rare Vascular Plants. Third Edition. Natural Heritage Information Centre, Ontario Ministry of Natural Resources, Peterborough, Ontario. 53 pages.
<http://www.mnr.gov.on.ca/MNR/nhic/species/rarevascular.pdf>
- OMMAH (Ontario Ministry of Municipal Affairs and Housing). 2005.** Provincial Policy Statement.
http://www.mah.gov.on.ca/userfiles/page_attachments/Library/1/789108_ppsenglish.pdf
- OMNR (Ontario Ministry of Natural Resources). 1989.** MNR 1:50,000 scale resource mapping: Halton Hills Oakville and Milton, Fish and Wildlife Resources.
- OMNR (Ontario Ministry of Natural Resources). 1993.** Ontario Wetland Evaluation System Southern Manual covering Hill's Site Regions 6 and 7, 3rd Edition. Revised 1994.
- OMNR (Ontario Ministry of Natural Resources). 1999.** Natural Heritage Reference Manual for Policy 2.3 of the Provincial Policy Statement. Ontario Ministry of Natural Resources, Peterborough.
- OMNR (Ontario Ministry of Natural Resources). 2000.** Significant Wildlife Habitat Technical Guide. 151pp. Appendix C & G.
- OMNR (Ontario Ministry of Natural Resources). 2007.** Oak Ridges Moraine Conservation Plan: Technical Paper Series, 2 - Significant Wildlife Habitat. 32 pp.
<http://www.mah.gov.on.ca/Page4808.aspx>
- OMNR (Ontario Ministry of Natural Resources). 2008.** Species at Risk in Ontario List.
<http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/246809.html>
- Ontario Regulation 162/06. 2006.** Policies, Procedures and Guidelines for the Administration of Ontario Regulation 162/06. Conservation Halton.
- OOA (Ontario Odonata Atlas). 2005.** Natural Heritage Information Centre, Ontario Ministry of Natural Resources. <http://www.mnr.gov.on.ca/MNR/nhic/odonates/ohs.html> (updated 15-02-2005).
- OPIF (Ontario Partners in Flight). 2006.** Ontario Landbird Conservation Plan: Lower Great Lakes/St. Lawrence Plain (North American Bird Conservation Region 13), Priorities, Objectives and Recommended Actions. Environment Canada/Ministry of Natural Resources. Draft. February 2006. <http://www.bsc-eoc.org/PIF/PIFOntario.html>
- Parish Geomorphic Ltd. 2001.** Geomorphological protocols for subwatershed studies. Submitted to: Regional Municipality of Ottawa-Carleton.
- Paul, M.J. and J.L. Meyer. 2001.** Streams in the Urban Landscape. Annual Review of Ecology and Systematics, 32: p. 333-365.

- Philips Planning and Engineering Limited. 2000.** Sixteen Mile Creek Subwatershed Areas 2 and 7 Study. General Report and Appendices.
- Philips Engineering Limited. 2003.** Indian Creek /Sixteen Mile Creek Sherwood Survey Subwatershed Management Study. Town of Milton. Draft Final Report. 165 pp + appendices.
- Philips Engineering Limited. 2005.** Environmental Study Report, Regional Road 25, Class Environmental Assessment. Regional Municipality of Halton.
- Plourde, S.A., E.L. Szepesi, J.L. Riley, M.J. Oldham and C. Campbell. 1989.** Distribution and Status of the Herpetofauna of Central Region, Ontario Ministry of Natural Resources. Parks and Recreational Areas Section, OMNR, Open File Ecological Report SR8903, Central Region, Richmond Hill, Ontario. 27pp.
- Rezendes, P. 1999.** Tracking and the Art of Seeing (Second Edition). How to Read Animal Tracks and Sign. Firefly Books. Willowdale, Ontario. 336 pp.
- Riviere, L. and S. McInnes. 1999.** Identifying Woodlands in Halton. Draft Report for Discussion. R.M. Halton Planning and Public Works Department.
- RMH (Region Municipality of Halton), 2005.** Halton Region Environmental Impact Assessment Guidelines. July 13, 2005. 14pp.
- Rothfels, C. 2006.** The Dragonflies and Damselflies (Odonata) of Halton Region, Ontario. pp. 135 – 158. *In:* J.K. Dwyer (Ed.) Halton Natural Areas Inventory 2006. Volume 2 – Species Checklists. 184pp.
- Rothfels, C. 2007.** Personal communication with Carl Rothfels, odonate expert and author of “The Dragonflies and Damselflies of Halton Region, Ontario” on July 20, 2007 to discuss the status of River Bluet (*Enallagma anna*).
- Rowe , J.S. 1972.** Forest Regions of Canada. Department of the Environment, Canadian Forest Service. Publication Number 1300, 172 pp + map.
- Sandilands, A. 2007.** Common Nighthawk. Pg. 308 – 309, *In*, M.D. Cadman, D.A. Sutherland, G.G. Beck, D. Lepage, and A.R. Couturier editors. *Atlas of the Breeding Birds of Ontario, 2001 – 2005*. Bird Studies Canada, Environment Canada, Ontario Field Ornithologists, Ontario Ministry of Natural Resources, and Ontario Nature, Toronto. xxii + 706 pp.
- Schumm, S.A., 1977.** The fluvial system: New York, John Wiley & Sons, 338 p.
- Sierra Club. 2004.** Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetlands (<http://iowa.sierraclub.org/Steve-Sierra%20web%20docs0526/WhereRiversAreBorn.pdf>)
- Selby, M. J. 1982.** Hillslope Materials and Processes. Oxford Univ. Press.

Snell, E.A. 1987. Wetland Distribution and Conversion in Southern Ontario. Working paper No. 48, Inland waters and Lands Directorate, Environment Canada.

TSH Associates. 2006. *North Oakville Creeks Subwatershed Study*. Submitted to: Town of Oakville.

Town of Milton. 2001. Town of Milton Official Plan.

Available: <http://www.milton.ca/plandev/officialplan.pdf>

Varga, S., D.Leadbetter, J. Webber, J. Kaiser, B. Crins, J. Kamstra, D. Banville, E. Ashley, G. Miller, C. Kingsley, C.Jacobsen, K. Mewa, L. Tebby, E. Mosley, E. Zajc. 2005. Draft. Distribution and Status of the Vascular Plants of the Greater Toronto Area (Draft, Varga et al 2005).. Ontario Ministry of Natural Resources . Aurora District. 96 pp.

Whiting, P.J., J.F. Stamm, D.F. Moog and R.L. Orndorff. 1999. Sediment-transporting flows in headwater streams. *Geological Society of America Bulletin*; v. 111; no. 3; p. 450-466.

Wolman, M.G., 1954. A method of sampling coarse river-bed material. Transactions of American Geophysical Union. 35: 951-956.

Wormington, A. 2006. The Butterflies of Halton Region, Ontario. pp. 113 – 134. *In*: J.K. Dwyer (Ed.) Halton Natural Areas Inventory 2006. Volume 2 – Species Checklists. 184pp.

Wormington, A. and W.G. Lamond. 2003. The Butterflies of Hamilton, Ontario. pp. 3–1 to 3–30 *In*: J.K. Dwyer (Ed.) *Nature Counts Project: Hamilton Natural Areas Inventory 2003 - Species Checklists*. Hamilton Naturalists' Club, Hamilton, Ontario. 282pp

APPENDIX 'A'
SUBWATERSHED AREAS 2 & 7
MANAGEMENT STRATEGIES



APPENDIX ‘A’
SUBWATERSHED AREAS 2 AND 7 MANAGEMENT STRATEGIES

7.4.1 General

It has been recognized that there tend to be two levels of management opportunities associated with the Subwatershed resources, those which apply to the whole of the subwatershed study area and those which relate to a specific location or environmental unit.

In addition, there are natural or man-made features which can be used to logically delineate or define development areas for the purpose of a more discrete assessment, these include:

<u>Natural</u>	<u>Man-made</u>
Watercourses	Roadways (major)
Watershed Divides	Land use (existing and proposed)
Topography (Escarpment)	Utility Corridors
Environmental Features	

The foregoing premise has been used to divide the developing land use (HUSP) within Areas 2 and 7 into the following neighbourhood areas (ref. Figure 9):

- *Milton South-West/South*
- *Milton North-West*
- *Milton North*
- *Milton Business Park*
- *Milton South-East*

These areas may or may not eventually represent the boundaries of future Secondary Plans, however, it is expected that the recommended management strategies can easily ‘cross’ the artificial boundaries established for this documentation process. [Note: As is evident, “Phase 1” has already been subject to a Secondary Planning Process (ref. MSH, December 1998) and “Existing Milton”, which represents the existing built up area of urban Milton, has only been presented for the purpose of documenting potential retro-fit and restoration opportunities].

Constraint Plans have been prepared for the entire developing area; in addition to one plan for each development area describes the neighbourhood’s management opportunities. These plans depict:

Constraint Plan (Drawings 1, 2 and 3)

- Woodlots/Wetlands and other Linked Terrestrial Features
 - High Constraint
 - Medium Constraint
 - Low Constraint
- Watercourses of Fisheries Significance
 - High

- Medium
- Stream Morphologic Constraints
 - Meander belt width
 - Sensitive points of gradient control
- Valley Setbacks
 - Geotechnical criteria
- Proposed Land Use

Opportunities Plan (Figures 9A to G)

- Terrestrial Unit Enhancement
 - Linkages/corridors
- Watercourses Protection Hierarchy
 - Protect/enhance in-site
 - Maintain as open; realignment possible
 - Eliminate as necessary; subject to function replication
- Stormwater Management
 - Optional facilities location
 - Diversion opportunities

7.4.2 Watercourse Systems Approach

The following discussion on management strategies for watercourse systems is predominantly from the physical perspective. Through the proper consideration and evaluation of the physical processes operative within a stream corridor, management decisions can be made to ensure most physical functions of the watercourse are maintained. This in essence permits natural biological and chemical attributes and functions to continue with minimal disturbance. In other words, if a watercourse is given an appropriate corridor to enable natural migration and linkage with its floodplain, the channel will eventually reach a state of dynamic equilibrium. In this scenario, the biological (aquatic and terrestrial) components, as well as chemical attributes are permitted to naturally adjust and function. This understanding is not new, as several regulatory agencies have produced guidelines for stream corridors (i.e. MNR, PPS). An illustrative example of the various setbacks and buffers for streams in a variety of settings is shown in Figure 10 (a) to 10 (c).

It is also recognized that this management approach is not possible for every watercourse, as some loss of headwater streams is inevitable. Further the extent to which this can be implemented varies with the physical setting and functional attributes (existing and future). For this to be effectively accomplished, integration with the Natural Heritage System (Section 7.4.3) and Stormwater Management (Section 7.4.4) is necessary.

The constraints, issues, concerns and opportunities regarding the watercourses within Subwatershed Areas 2 and 7 have been previously presented in earlier sections. Given this information, the components for a management strategy are presented below and grouped into primary, secondary and tertiary levels corresponding to importance, system function, costs and success in achieving management goals.

Primary Items

- Within the main channels (greater than 3rd order – ref. Tables 3.8 and 3.9 and Watercourse Systems Technical Appendix – Section 1.3), the focus should be towards maintenance and protection: crossings and disturbance should be minimized. Where a crossing is warranted, it should span the valley.
- Erosion sites along the main channel within Subwatershed Area 2 should be mitigated, especially the sites at Derry Road and further downstream, adjacent to Regional Road 25 and upstream of Britannia Road.
- All channels (less than, and including, 3rd order) in the study area should have a stream corridor based on the meander belt width of the appropriate stream reach.
- The invert of the Omagh Tributary (Reach 7-Ixo) should not be altered, as the gradient is already low and susceptible to aggradation.

Secondary Items

- Based on the functional attributes, including biological elements, the minor tributaries should be maintained as open channels.
- The alteration (lowering, straightening) of tributary channels should be avoided in order to permit the channel to obtain dynamic stability (i.e. ensure that channel function will not be impaired). This will ensure a reduction in long term maintenance. Targets for implementation could be entrenchment values greater than four; no reduction in stream length or gradient, stream corridor based on meander belt width or equivalent, erosion along outside of meanders not to exceed 2cm a year.
- In-stream treatment to control erosion and reduce erosion potential along the Kelso Branch (reach 2-IV and reach 2-V).
- Restore functional attributes to straightened tributary sections (North Branch; reach 2-HP; Centre Tributary – reach 2-VIIc; tributaries along 2-Viw).

Tertiary Items

- Restore hardened and straightened reaches through Milton (reaches 2-III and 2-IV).

7.4.3 Natural Heritage Systems Approach

“Natural heritage includes geological features and landforms; associated terrestrial and aquatic ecosystems; their plant species, populations and communities; and all native animal species, their habitats and sustaining environment.” - A Natural Heritage Area Strategy’ – OMNR, 1992.

Subwatershed Areas 2 and 7 pose a number of challenges in terms of developing a realistic and defensible Natural Heritage System (NHS). Given the extent of existing degradation of natural features, a ‘net gain’ principle is proposed that would incorporate strategies to enhance habitat cover and linkage functions in tableland and valleylands outside of existing ESA’s, including:

- Consolidation of fragmented natural habitats or irregular natural feature boundaries in valley and tableland settings, using naturalization, reforestation, and/or habitat restoration

- Protection of successional habitats on the same basis as more mature habitats
- Augmentation of stream corridors to exceed width targets
- Naturalization of portions of public open space and private recreational lands (such as golf courses)
- Integration of new or established features (hedgerows, plantations, small woodlots, successional features, utility easements) as linkages, particularly oriented east to west
- Landscape-level management of species diversity, through the widespread promotion and use of native plant materials, and 'biodiversity recycling' practices

Section 7.4.6 identifies specific measures that can be integrated during secondary planning, to establish targets for 'net gain' of natural habitat specific to conditions in each future development area.

The following is a summary of key features and relevant planning issues to be accommodated within the overall potential NHS approach:

Terrestrial

- Currently defined core natural areas, as summarized in the Watershed Plan (1996), are confined to the Niagara Escarpment and the Sixteen Mile Creek ESA's. Development of these areas is restricted by provincial, regional and local policy.
- Outside of the Sixteen Mile Creek ESA, the natural corridors afforded by the East and Main Branches of Sixteen Mile Creek have been extensively encroached upon by agricultural and recreational (golf course) uses, and urbanization in the Town of Milton. These well-defined valley areas should be designated as "significant valleylands" under the Provincial Policy Statement.
- No habitats of provincially significant or endangered terrestrial species have been identified to date outside of designated ESA's or ANSI's; however, species considered rare or uncommon in the Region, or of conservation concern, have been documented.
- The Highway 401 corridor bisects the watersheds, posing a significant barrier to movement of terrestrial vertebrates in particular. Lands in the vicinity of the Highway 401 will likely be developed for industrial and commercial uses, and improved stream linkages may be possible in the future.
- No Provincially Significant Wetlands (PSW's) have been identified previously in Subwatershed Areas 2 and 7; eight locally-significant wetlands have been evaluated as part of the present study. These would be considered for protection under current Official Plans.
- There are several major forest stands located in the eastern half of Subwatershed Area 7; although disturbed in some areas, these qualify as "significant woodlands" under the terms of the Provincial Policy Statement on the basis of their size, hydrologic sensitivity, proximity to other natural features, forest structure, and potential as forest interior habitats.
- Many smaller forest areas do not meet current standards for "significant woodlands"; however, the Region of Halton has proposed a draft policy to protect any woodlot 2 ha or larger in future urban areas located below the Niagara Escarpment (Riviere and McInnes, 1999); this policy has not been adopted to date.
- The Halton Urban Structure Plan has recommended the establishment of an 'urban separator', comprised of floodplain and agricultural lands, extending eastward from the East Branch of Sixteen Mile Creek.

Aquatic

- Due to the hydrogeology of the sub-watershed, permanent flow is limited to the Main Branches of the creek and a few tributaries.
- The permanently flowing streams generally have diverse fish communities with either coldwater or “vulnerable” fish species present.
- Some of the intermittent streams provide seasonal habitat for fishes from the permanently flowing streams.
- Many of the ephemeral streams provide little in the way of direct fish habitat.

With this situation in mind, a NHS hierarchy is proposed that would be comprised of:

- a) Primary features with recognized existing natural heritage value, including designated/regulated features; management strategies for these features are to protect and restore/enhance where necessary/possible.
- b) Secondary enhancement features with high potential for restoration and linkage creation. The management strategies for these features are to restore/enhance where possible; and
- c) Tertiary features that can provide a series of optional linkages, particularly those oriented east to west. These are further described below:

(a) Primary NHS Features

- High fisheries constraint reaches and buffers (ref. Figure 10 (d) and 10 (e) of East and Main Branches and the west fork of the North Branch.
- Designated Environmentally Sensitive Areas (Sixteen Mile Creek Valley, Milton Heights, Crawford Lake – Rattlesnake Point Escarpment Woods, Hilton Falls) and associated Areas of Natural and Scientific Interest
- Significant woodlands and valleylands as defined under the Provincial Policy Statement
- Locally significant wetlands associated with coldwater reaches of East and Main Branches
- Total corridor width target – at least 100 m*

(b) Secondary NHS Features

- Medium fisheries constraint reaches and buffers (ref. Figure 10 (d) and 10 (e))
- Locally significant wetlands other than those associated with high fisheries constraint reaches
- Woodlands exceeding 2 ha in size, with the highest priority on those of suitable area and shape to support forest interior conditions, or those which could achieve this category with limited naturalization/reforestation efforts
- Forest remnants within ‘urban separator’ lands
- Total corridor width target – at least 50 m

(c) Tertiary NHS Features

- Hedgerow and roadside tree linkages (existing major or replanted)
- Lands in early stages of secondary succession (old field, tree and shrub-dominated successional meadows)
- Rail and utility corridors with capability for management (present or future) in a naturalized context
- Urban land use separators (e.g. small woodlots, hedgerows and plantations that serve to delimit various urban land uses e.g. highway industrial vs. residential lands)
- Created stormwater management facilities/conveyances
- Total corridor width target – at least 15 m

*minimum width to encourage species movement (Env. Canada, 1998)

7.4.4 Stormwater Management Approach

Stormwater Management strategies for each subwatershed can be sub-divided as follows:

- *Quality Management of*
 - (i) *pollutants*
 - (ii) *thermal inputs*
- *Quantity Management of*
 - (i) *baseflow*
 - (ii) *erosion causing flows*
 - (iii) *adverse flooding*

As noted in Section 7.1, strategies for areas outside of the Phase 1 Secondary Plan will tend to be more conceptual and general in nature, given the absence of detailed land use planning fabric.

In addition to the foregoing, stormwater management strategies, recommended for Areas 2 and 7, will be further segregated into those affecting all lands on a 'broad-scale' or 'subwatershed-wide' verses site-specific management approaches.

All stormwater management strategies, be they broad-scale or site specific, need to be integrated with the strategies for Natural Heritage Systems and Watercourse Systems.

Quality Management

(a) Targets:

Pollutants

The Sixteen Mile Creek Watershed Plan recommended a Level 1 Habitat protection criteria (approximately equivalent to 80% annual suspended solids removal). This criteria has been confirmed as appropriate due to the presence of vulnerable species in the Main and East Branch of the Sixteen Mile Creek.

TABLE 7.13 WATER QUALITY STORAGE REQUIREMENTS (FROM MOEE 1994)					
Protection Level	SWMP Type	Storage Volume (m ³ /ha for Impervious Levels)			
		35%	55%	70%	85%
Level 1	Infiltration	25	30	35	40
	Wetlands	80	105	120	140
	Wet Pond	140	190	225	250

Thermal Input

Subwatershed Area 2 is considered particularly vulnerable to increases in stream temperatures due to the effects of urbanization and stormwater management. Near lethal temperatures (i.e. greater than 25°C) have been measured in the channel through Milton. Measures to keep temperatures below 25°C should be implemented.

(b) Opportunities:

- | | |
|--|--|
| <p>1. Source</p> <ul style="list-style-type: none"> – reduced lot grading – on-site ponding areas – oil/grit separators (lot level) | <p>2. Conveyance</p> <ul style="list-style-type: none"> – enhanced grass swales – protect existing swales/watercourses – pervious pipes |
| <p>3. End-of-Pipe</p> <ul style="list-style-type: none"> – infiltration basins – wet ponds – wetland – hybrids | <p>4. Watercourse Management</p> <ul style="list-style-type: none"> – shading |
| | <p>5. “Do Nothing”</p> <ul style="list-style-type: none"> – cash-in-lieu contributions to regional management systems |

(c) Evaluation Criteria:

Physical:

- Level 1 treatment
- Habitat enhancement
- Residual quantity benefits
- Functional implementability
- Serviceability

Social:

- Public acceptability
- Safety issues
- Aesthetics
- Marketable

Economic:

- Capital costs
- Land requirements
- Routine operations and maintenance requirements
- Phasing opportunities
- Administration costs