# Flamborough-Burlington Natural Capital

## Assessment of Ecosystem Service Values in the MTO West Corridor Planning Area

**Jeff Wilson, Mike Kennedy, Ryan Trenholm**

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Stop Escarpment Highway
COALITION
www.stophighway.com

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*Flamborough-Burlington Natural Capital: Assessment of Ecosystem Service Values in the MTO West Corridor Planning Area*
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Green Metrics Ltd. is an independent firm that specializes in solutions for environmental and natural resource problems. It offers research, analysis, writing and networking support to governments, corporations and non-profit organizations for policy analysis and strategy development at local, regional and national levels. On an as-needed basis, Green Metrics Ltd. brings together associates from ecological, social and economic disciplines to provide expertise in natural resource development, land-use change and community sustainability.

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## Acknowledgements

This report was developed as part of a consulting contract for the Stop Escarpment Highway Coalition.

As of May 2011, the coalition consisted of the following eleven members:

| | |
|---|---|
| Citizens Opposed to Paving the Escarpment (COPE) | www.stophighway.com |
| Cedar Springs Community | web.me.com/thomassimpson/ CedarSpringsCommunity/Home.html |
| BurlingtonGreen | www.burlingtongreen.org |
| Lowville Area Residents Association (LARA) | www.welcometolowville.com |
| Oakvillegreen Conservation Association | www.oakvillegreen.org |
| Coalition of the Niagara Escarpment (CONE) | www.niagaraescarpment.org |
| Protecting Escarpment Rural Land (PERL) | www.perlofburlington.org |
| Milton Green Citizens Group | www.miltongreen.info |
| Environment Hamilton | www.environmenthamilton.org |
| Preservation of Agricultural Lands Society | people.becon.org/~pals/ |
| Sidrabene Latvian Camp | www.sidrabene.org |
| Citizens at City Hall (CATCH) | www.hamiltoncatch.org/index.php |

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# Executive Summary

Green Metrics was commissioned by the Stop Escarpment Highway Coalition to examine the ecosystem services provided by the area's natural capital within the MTO West Corridor Planning Area.

Drawing on the assessment of ecosystem service values conducted by the Ontario Ministry of Natural Resources for the Southern Ontario landscape, this report verified and updated ecosystem service values to be suitable for the study area. Applying the refined values to the study provided an approximation of the natural capital value that exists in the Flamborough-Burlington West Corridor Planning Area.

| Ecosystem Service | Total Value Estimate ($/Year) |
|---|---:|
| Recreation | 110,052,850 |
| Aesthetic / Amenity | 150,609,719 |
| Other Cultural | 31,029,391 |
| Pollination / Seeding | 6,719,344 |
| Habitat Refugium | 73,021,098 |
| Gas Regulation | 16,730,829 |
| Soil Regulation | 27,884 |
| Nutrient Regulation | 48,978,578 |
| Water Supply | 160,067,729 |
| Disturbance Regulation | 314,446,550 |
| **Total** | **911,683,973** |

The natural capital was estimated to provide a flow of nearly $912 million per year in ecosystem service benefits, with disturbance regulation, aesthetic/amenity, recreation, and water supply services providing the bulk of the value.

These values highlight the significant benefits that natural capital can provide particularly when natural features and functioning occur in such close proximity to urban populations, as is the case with Flamborough-Burlington area. Combined, recreation and amenity values account for nearly 30% of the total value.

While it was outside the scope of this analysis to directly assess the impacts that a transportation corridor could have on the ecosystem services in the area, some high level conclusions can be drawn.

1. Natural capital and the associated flow of ecosystem services within the study area are particularly valuable as a result of high quality natural features in such close proximity to large urban populations who derive significant value from those natural features.
2. Ignoring such valuable ecosystem services when making land use decisions within the study area risks undermining those values that are important, not only to those that live within the study area but also those who live throughout the region.

While the assessment in this report has provided an approximation that admittedly carries some uncertainty, the estimate of $912 million does provide a sense of the order of magnitude natural capital values can represent, and the values should not be ignored when making long-term land-use decisions.

# 1. Introduction

Over the last decade there has been a surging interest in the ideas of natural capital and the ecosystem services that flow from that capital. These trends reflect a growing awareness that human well-being is fundamentally connected to a healthy functioning natural environment. Until these ideas are formally incorporated into policy and accounted for in decision-making we risk continued losses to that which sustains our quality of life.

## 1.1. Purpose of the Report

Green Metrics was commissioned by the Stop Escarpment Highway Coalition (SEHC) to examine the proposed Flamborough-Burlington transportation corridor and assess the ecosystem services provided by the area's natural capital. The research conducted and outlined in this report does not argue for or against construction of transportation infrastructure. Rather, the report is intended to contribute to a more accurate benefit-cost analysis when evaluating corridor alternatives. It insists that such decisions need to consider their implications on elements of natural capital and the resulting flow of ecosystem services. Elements that are integral to the well-being of people that live within the planning area and those who live throughout the Greater Golden Horseshoe region are at stake.

Drawing on the research that has already been completed in Southern Ontario the objectives of this report are as follows:

- Demonstrate the importance of natural capital and potential ecosystem service values in the MTO West Corridor Planning Area (WCPA).
- Highlight the need to carefully examine changes to natural capital and ecosystem services values when making land-use decisions.

## 1.2. Outline of the Report

The report has been organized into five sections, including the introduction, and is structured as follows:

- Chapter 2 summarizes some of the previous natural capital assessments that have been done, focusing on those completed in Southern Ontario.
- Chapter 3 outlines the approach used to assess natural capital values in the WCPA.
- Chapter 4 presents and describes the results and findings of the analysis.
- Chapter 5 provides a summary and recommendations.

# 2. Review of Existing Natural Capital Assessments

Since the release of the Millennium Ecosystem Assessment[1] and more recently The Economics of Ecosystems and Biodiversity[2], there has been a growing movement in Ontario to push for incorporating natural capital and ecosystem service values into decision-making, starting with the Greenbelt[3] and Credit Valley Conservation[4]. The Ministry of Natural Resources (MNR), also aware of the growing importance such information can play in the management of Ontario's natural resources, commissioned a study by leading experts linked to the Gund Institute for Ecological Economics at the University of Vermont (henceforth referred to as the MNR report)[5]. In this section we examine these and other natural capital assessments relevant to Southern Ontario.

## 2.1. Summary of Studies

As an example of the type of information provided in the MNR report and to put that work into the context of assessments in Ontario and other jurisdictions, four relevant natural capital studies (three from Ontario and one from Maryland) are summarized in Table 1. The table summarizes and compares average per hectare (ha) values based on the land cover categories used in the MNR reports.

It is difficult to deconstruct the differences between specific values for a given land cover category as they depend on the value transfer approach used, the number of ecosystem services accounted for in each land cover category, and the author's professional judgment in deciding which values to transfer. The land cover categories also don't match exactly. As such, direct comparison between reported per ha values should be done carefully. However, some general observations can be made.

Depending on the land cover category, some of the value estimates resulting from these studies are similar and others are vastly different. This underscores the uncertainty that can be found in these assessments as well as gaps in data that have yet to be filled. However, among the land covers more thoroughly studied (agriculture, forest: non-urban, wetlands: non-urban, non-coastal) there are surprising similarities and common trends in the value estimates.

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[1] Millennium Ecosystem Assessment (2003). Ecosystems and Wellbeing: A framework for Assessment.
[2] TEEB (2010). The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.
[3] Wilson, S.J. (2008). Ontario's wealth, Canada's future: Appreciating the value of the Greenbelt's ecoservices. David Suzuki Foundation, Vancouver, British Columbia.
[4] Kennedy, M. and J. Wilson. (2009). Natural Credit: Assessing the Value of Natural Capital in the Credit River Watershed. Credit Valley Conservation, Mississauga, Ontario.
[5] Troy, A. And K. Bagstad. (2009). Estimating Ecosystem Services in Southern Ontario. Ontario Ministry of Natural Resources, Toronto, Ontario.

**Table 1. Comparison of per hectare ecosystem service values by land cover type reported in Troy and Bagstad (2009)**

<table>
<tr><th rowspan="2">Southern Ontario Land Cover Categories</th><th>Southern Ontairo[6]</th><th>Credit River Watershed[7]</th><th>Ontario Greenbelt[8]</th><th>Cecil County[9]</th></tr>
<tr><th>2008 $CAD/ha</th><th>2007 $CAD/ha</th><th>2005 $CAD/ha</th><th>2006 $USD/ha</th></tr>
<tr><td>Agriculture</td><td>291</td><td>688</td><td>477</td><td></td></tr>
<tr><td>Grassland/pasture/hayfield</td><td>353</td><td>787</td><td>1,618</td><td></td></tr>
<tr><td>Forest: non-urban</td><td>4,443</td><td>6,416</td><td rowspan="4">5,414</td><td>4,870</td></tr>
<tr><td>Forest: urban</td><td>25,843</td><td rowspan="2">9,719</td><td></td></tr>
<tr><td>Forest: suburban</td><td>14,777</td><td></td></tr>
<tr><td>Forest: adjacent to stream</td><td>4,552</td><td>18,819</td><td>21,353</td></tr>
<tr><td>Forest: hedgerow</td><td>1,023</td><td></td><td>1,678</td><td></td></tr>
<tr><td>Urban herbacious greenspace</td><td>43,788</td><td></td><td>1,667</td><td></td></tr>
<tr><td>Open water: river</td><td>55,553</td><td>13,400</td><td>335</td><td></td></tr>
<tr><td>Open water: urban/suburban river</td><td>236,392</td><td></td><td></td><td></td></tr>
<tr><td>Open water: inland lake</td><td>5,050</td><td></td><td></td><td></td></tr>
<tr><td>Open water: great lake near shore</td><td>795</td><td></td><td></td><td></td></tr>
<tr><td>Open water: estuary/tidal bay</td><td>1,852</td><td></td><td></td><td></td></tr>
<tr><td>Wetlands: non-urban, non coastal</td><td>15,171</td><td rowspan="2">31,689</td><td>14,153</td><td>17,679</td></tr>
<tr><td>Wetlands: urban/suburban</td><td>161,420</td><td></td><td></td></tr>
<tr><td>Wetlands: great lakes coastal</td><td>14,761</td><td></td><td></td><td>11,390</td></tr>
<tr><td>Beach</td><td>89,608</td><td></td><td></td><td></td></tr>
</table>

The estimates for forest cover in Southern Ontario and the Credit River Watershed both show that forest area closer to population centres (i.e. forest: urban and forest: suburban) are more highly valued than those in rural areas. This partially reflects the limited distribution of forest cover (scarcity) and the larger number of people that benefit from those areas. Forest values in the Credit River Watershed also highlight the increased values provided by forest cover in riparian areas (land-water interface along streams, rivers, and lakes), reflecting increased functions that forests play in these areas (i.e. flood control, water purification, etc.). This is also demonstrated in the Cecil County figures.

It is also important to note the primary objective of all these studies has been to build awareness, encourage dialogue among stakeholders, and draw attention to the importance of accounting for ecosystem service values when considering land use changes. As such, estimated values are not recommended for assessing specific land use trade-offs. However, the estimates do signal the significant values that can be attributed to natural capital and

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6 Troy, A. And K. Bagstad. (2009). Estimating Ecosystem Services in Southern Ontario. Ontario Ministry of Natural Resources, Toronto, Ontario.

7 Kennedy, M. and J. Wilson. (2009). Natural Credit: Assessing the Value of Natural Capital in the Credit River Watershed. Credit Valley Conservation, Mississauga, Ontario.

8 Wilson, S.J. (2008). Ontario's wealth, Canada's future: Appreciating the value of the Greenbelt's ecoservices. David Suzuki Foundation, Vancouver, British Columbia.

9 Weber, T. (2007). Ecosystem Services in Cecil County's Green Infrastructure. Technical Report for the Cecil County Green Infrastructure Plan.

call for more detailed trade-off analysis for land use changes on a case-by-case basis, particularly when they involve significant expenditure of public dollars.

## 2.2. Key Messages from the Literature

The literature summarized above highlights a few key messages echoed in this report. These can be summarized as follows:

1. Ecosystems provide services of significant value that should be taken into account when assessing trade-offs from land use change.
2. There are a number of techniques that exist to measure and quantify ecosystem service values and they that can be tailored to suit the needs of a given research project, policy option or decision criteria.
3. Ecosystem service values are highly dependent on their socio-economic, spatial, and temporal context.

# 3. Study Approach

This section describes the study area, outlines how the values were determined and applied to the study area, and highlights the limitations in the approach.

## 3.1. Study Area

The overall study area for this research was defined as the Flamborough-Burlington WCPA identified by the red dashed line in Figure 1. Figure 1 also depicts the overlap between the study area and local watersheds.

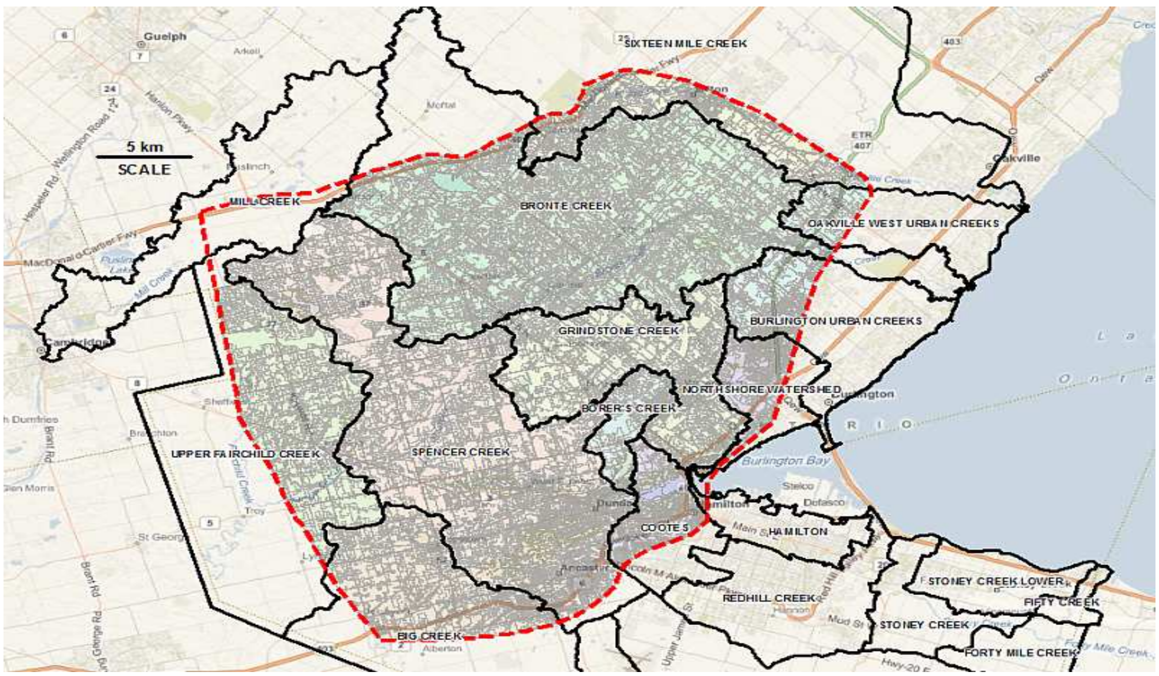


**Figure 1. Flamborough-Burlington West Corridor Planning Area**

## 3.2. Value Transfer Approach

In order to provide an assessment of the natural capital value for this research within the time, budgetary, and data constraints, determining values for the WCPA had to rely on value transfer using existing research estimates. Given the available information for the study area it was not possible to apply value transfer techniques to the level of detail that was done in the Credit River Watershed. However, the assessment conducted by the MNR for the Southern Ontario landscape used a comprehensive, spatially explicit approach to transferring average per ha values from the original study site to Southern Ontario[10].

The values reported by MNR were chosen as a starting point since the average per ha values corresponded reasonably well with the land cover data available for the study area.

[10] The approach used in the MNR report is referred to as unit value transfer (see Appendix).

However, before applying the per hectare values reported by MNR, we verified the value transfer approach, and sought to modify and fill data gaps where possible.

## 3.2.1. Verification of Value Transfer Estimates in the MNR Study

The verification of value transfer estimates from the MNR report was done to ensure a suitable level of comfort in using the estimates reported for the purposes of this research. The verification process can be summarized as follows:

- Took a random sample of 25 studies from the MNR report to verify suitability for the purposes of this research.
- Each study was assessed based on expert opinion and guided by the following questions:
    - Was the study site context (i.e. population size, standard of living, and land use pressures) similar to Flamborough-Burlington area?
    - Was the ecological context of the study suitable for the land cover and ecosystem service category it was applied to?

While this process was subjective, it was the opinion of the researchers that the studies used in the MNR study were suitable for Flamborough-Burlington area, given that the research purpose was not to analyze any specific policy or decision but to draw attention to broad values that exist for natural capital in the area.

## 3.2.2. Selection, Modification, and Update of Values

In an attempt to update and fill data gaps in the Southern Ontario values, a search of the literature was conducted using the Environmental Value Resource Inventory (EVRI) database[11] to identify recent studies relevant to the study area.

The following criteria were used:

- Published in peer reviewed academic journals;
- Value was estimated using primary valuation;
- Study location existed in a temperate climate zone;
- Valuation occurred in a high income country; and
- Published between 2008 and the present.

After running the criteria through the EVRI database 23 studies were found, of which six were determined to suitable for the Flamborough-Burlington study area yielding seven new value point estimates that were used to augment the values reported in the MNR study. The result was an updated database of average per hectare ecosystem service values divided into a number of land cover categories. Land cover categories matched the MNR study (see Table 1 for an itemized list).

[11] EVRI is a searchable storehouse of empirical studies on the economic value of environmental benefits and human health effects. For more information see www.evri.ca.

These new estimates only had a minor impact on the total value estimates presented in Chapter 4. However, they did allow additional ecosystem services to be accounted for which were not included in the MNR report.

### 3.2.3. Application of Ecosystem Service Values to the Study Area

The application of ecosystem service values from the updated database to the study area required a three-step process, which is summarized as follows:

1. Establishing the amount of land cover within the study area and matching each land cover to the land cover categories in the values database.
2. Establishing a price matrix[12] containing values for each land cover – ecosystem service combination.
3. Applying the price matrix to the land cover area for each watershed.

Land cover categories within the study area were based on the SOLARIS[13] landscape level inventory of natural, urban, and rural areas. Each SOLARIS land cover definition was carefully compared with the detailed description provided in the MNR report to determine the most appropriate match. Since the spatial analysis conducted in the MNR report was built from SOLARIS data the categories fit quite closely, with the exception of capturing the detailed difference between urban and non-urban contexts[14].

The next step was to establish a price matrix of the most appropriate values from the updated MNR database and allocate those values to the appropriate land cover categories available for the Flamborough-Burlington study area. The price matrix captured the urban, suburban, and rural differences in value by using a weighted average of per ha values (only for the categories that had such differentiation: forests, wetlands, and open water). The weight was based on the total area of those land covers across Southern Ontario[15]. This resulted in a price matrix of average per hectare values that could be applied to the area of each land cover type within the study area. Table 2 summarizes how updated MNR values were matched with land cover categories for the study.

[12] Each land cover category has a series of corresponding per ha values, one for each ecosystem service that could be estimated and associated with each land cover type. The result of combining all land covers and associated ecosystem service values in to a single table is what is referred to here as the price matrix.
[13] SOLARIS refers to the Southern Ontario Land And Resource Information System, a geo-spatial database of land use and land cover.
[14] It should be noted that with more time and geo-spatial analytical resources the allocation of land covers in the study area could be matched exactly to the MNR report.
[15] This has the implicit assumption that the distribution of higher valued urban and suburban land covers are in the same proportion in the study area as they are across Southern Ontario. Given the location of the study this likely underestimates the amount of urban and suburban area.

**Table 2. Land cover classification comparison**

| MNR Report Land Cover Categories[1] | SOLARIS 1.1 Land Cover Categories | Application of Values to the Study Area |
|---|---|---|
| Agriculture | Annual Crop<br>Mixed Crop<br>Idle Land<br>Orchards | Agriculture values were applied to SOLARIS aggregated area |
| Grassland/pasture/hayfield | Perennial Crop | Grassland/pasture/hayfield values were applied to SOLARIS Perennial Crop area |
| Forest: non-urban<br>Forest: urban<br>Forest: suburban | Forest<br>Coniferous Forest<br>Mixed Forest<br>Deciduous Forest<br>Plantations | Average value of Forest: non-urban, urban, suburban (weighted by area) were applied to SOLARIS aggregated area |
| Forest: hedgerow | Hedge Rows | Forest: hedgerow values were applied to SOLARIS hedge row area |
| Urban herbacious greenspace | Built-up Area Pervious | Urban herbacious greenspace values were applied to SOLARIS built-up pervious area |
| Open water: river<br>Open water: urban/suburban river<br>Open water: inland lake | Open Water | Average value of Open water: river, urban/suburban, inland lake (weighted by area) were applied to SOLARIS open water area |
| Wetlands: non-urban, non coastal<br>Wetlands: urban/suburban | Swamp<br>Fen<br>Bog<br>Marsh<br>Shallow Water | Average value of Wetlands: non-urban/non-coastal, urban/suburban (weighted by area) were applied to SOLARIS aggregated area |

(1) A number of MNR report value estimates were excluded as they were not relevant to the study area. Those excluded were all ecosystem service values for wetlands: great lakes coastal; beach; open water: great lakes near shore; and open water: estuary/tidal bay. As well, forest: adjacent to stream was excluded due to data limitations; future research should carefully assess the unique services provided by riparian ecosystems.

## 3.3. Discussion of the Approach

The approach taken in this study was a form of value (or benefits) transfer. As a result it should be noted that the values reported here are only as good as the original assessment and therefore carry some uncertainty[16]. However, care was taken to verify and ensure the studies used maintain a certain level of rigor (see Section 3.2.1.). In addition, lack of data is often a limiting factor when assessing the value of ecosystem services or traditional

[16] For a detailed account of the benefits and limitations of value transfer see Desvouges, W. H., F. R. Johnson and H. S. Banzhaf, *Environmental Policy Analysis with Limited Information: Principles and Applications of the Transfer Method* (Northampton, MA: Edward Elgar, 1998).

economic studies. Consequently, only a fraction of all ecosystem services that potentially exist within the study area could be accounted for. This means that values represent only a partial estimate. With additional technical studies the total value of all ecosystem services would increase.

As a result, values reported in Section 4 should not be interpreted as absolute, but rather as approximate values to be used for the purpose of communicating the importance of ecosystem service values and the dangers of ignoring them. Incorporating ecosystem service values into trade-off analysis from land use changes should use primary valuation techniques (see Appendix) whenever possible. However, when primary valuation is not feasible, value transfer has been argued to be a suitable alternative[17], but studies should be carefully selected based on appropriate criteria and adjusted to suit the policy context.

[17] Ibid.

# 4. Value of Natural Capital in the Planning Area

This section presents the results of the natural capital assessment and summarizes the assessment by ecosystem service, land cover, and watershed. The estimated total value of natural capital in the MTO defined WCPA is approximately $912 million annually. All values are reported in 2011 $CAD.

## 4.1. Value of Natural Capital by Ecosystem Service

The annual value for each ecosystem service is summarized in Table 3. As can be seen, disturbance regulation is by far the most significant ecosystem service provided in the study region, representing over 30% of the total value. This is not surprising given the spatial context of the study area, with large population and urban centres that rely on natural capital throughout the area to minimize peak water flows and flooding.

**Table 3. Natural capital value estimates by ecosystem service for the entire study area**

| Ecosystem Service | Total Value Estimate ($/Year) [1] |
|---|---:|
| Recreation | 110,052,850 |
| Aesthetic / Amenity | 150,609,719 |
| Other Cultural | 31,029,391 |
| Pollination / Seeding | 6,719,344 |
| Habitat Refugium | 73,021,098 |
| Gas Regulation | 16,730,829 |
| Soil Regulation | 27,884 |
| Nutrient Regulation | 48,978,578 |
| Water Supply | 160,067,729 |
| Disturbance Regulation | 314,446,550 |
| **Total** | **911,683,973** |

(1) Total value estimates are reported in 2011 $CAD

Water supply also accounts for a relatively significant portion of the total value at $160 million per year. The natural capital throughout the study area undoubtedly provides critical water supply functions to all the residents who live in the rural countryside.

Other significant values include recreation and amenity values. Again this is driven by (i) the close proximity of natural capital to population and urban centres, and (ii) the quality of—and demand for—recreational and amenity opportunities that exist in the study area. Combined recreation and amenity values account for nearly 30% of the total value.

The significance of recreation and amenity values across the study region is not surprising. The area is well known for the Niagara Escarpment that runs through the study area providing high quality recreational opportunities such as hiking, bird watching, rock climbing, as well as other amenities. In addition the remaining natural features within the study area and throughout the region are highly fragmented by agriculture, urban, and suburban areas. The increasingly limited amount of high quality and accessible natural features drive the high value people place on the remaining features.

# 4.2. Value of Natural Capital by Land Cover

Natural capital values have also been expressed by land cover type as summarized in Table 4. Natural capital assessments of this type often find that wetlands provide the largest proportion of total value, as is also seen in Table 4. This is partially the result of the significant role wetlands play in providing ecosystem functions that are of value to humans, such as reducing flood risks, purifying water, and assimilating waste, among many others. Wetlands are also one of the more thoroughly studied ecosystems. As a result more ecosystem services have been accounted for and therefore values are relatively more complete than other land covers.

**Table 4. Natural capital value estimates by land cover for the entire study area**

| Land Cover | Area (in ha) | Total Value Estimate ($/Year) [1] |
|---|---|---|
| Forest | 13,374 | 136,644,049 |
| Agriculture | 39,679 | 12,238,835 |
| Grassland | 6,089 | 2,280,824 |
| Hedgerow | 997 | 1,080,749 |
| Urban Green Space | 1,869 | 86,767,133 |
| Wetland | 12,171 | 658,715,615 |
| Open Water | 11,111 | 13,956,769 |
| **Total** | **85,667** | **911,683,973** |

(1) Total value estimates are reported in 2011 $CAD

Wetland and forest ecosystems were estimated to account for the bulk of the natural capital and provide significant flows of ecosystem service values. Combined, wetland and forest cover account for 87% of the total flow of benefits. This result emphasizes the significant benefits that natural features can provide when natural capital is in close proximity to large urban populations.

# 4.3. Value of Natural Capital by Watershed

Breaking the values up by the various watersheds that make up the study area shows that Bronte, Spencer, and Grindstone Creeks have the highest natural capital value at $275.4 million, $262.1 million, and $108.4 million per year, respectively (Table 5). This is driven more by the amount of natural capital (wetlands and forest) in these areas as opposed to the natural capital itself being of higher value. However, it does signify the potential for lost value if development projects do not carefully account for their impact on the limited amount of natural capital that remains.

**Table 5. Natural capital value estimates[1] by land cover for each watershed within the study area[2]**

| Land Cover | Big Creek | Borer's Creek | Bronte Creek | Burlington Urban Creeks | Cootes | Grindstone Creek | Hamilton | Northshore | Oakville West Urban Creeks | Sixteen Mile Creek | Spencer Creek | Upper Fairchild |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forest | 6.3 | 2.3 | 47.8 | 3.8 | 5.4 | 11.0 | 0.1 | 3.9 | 1.6 | 7.8 | 37.2 | 9.3 |
| Agriculture | 1.2 | 0.3 | 3.7 | 0.3 | 0.1 | 1.4 | * | 0.2 | 0.3 | 0.6 | 3.0 | 1.2 |
| Grassland | 0.2 | * | 0.6 | 0.1 | * | 0.2 | | * | * | 0.1 | 0.6 | 0.4 |
| Hedgerow | * | * | 0.4 | * | * | 0.1 | | * | * | 0.1 | 0.3 | 0.1 |
| Urban Green Space | 9.8 | 1.6 | 16.0 | 3.9 | 9.1 | 11.4 | 0.6 | 7.1 | | 9.1 | 18.1 | * |
| Wetland | 25.4 | 7.7 | 204.3 | 0.8 | 7.6 | 83.4 | | 1.9 | 1.1 | 13.8 | 199.8 | 112.9 |
| Open Water | 0.4 | * | 2.6 | 0.1 | 4.4 | 0.8 | * | 0.1 | | 2.1 | 3.0 | 0.4 |
| **Total** | 43.3 | 12.0 | 275.4 | 8.9 | 26.7 | 108.4 | 0.7 | 13.2 | 3.0 | 33.6 | 262.1 | 124.4 |

(1) Total value estimates are reported in millions of 2011 $CAD per year.

(2) Cells marked with an asterisk (*) indicates those cells that are less than $50,000 and greater than zero, but when rounded to the nearest hundred thousand would be labeled as zero. Blank cells indicate land covers that do not exist for the associated the watershed.

# 5. Policy Implications

If the value of natural capital is not accounted for (quantitatively or qualitatively) in policy and land-use decision-making, we implicitly assume that the flow of benefits provided by functioning ecosystems are worth nothing. As a result, we risk advancing well intentioned projects or policy that ultimately reduce well-being and result in a lower quality of life for everyone.

Historically, due to the complexity of obtaining accurate values they often went unaccounted for. Recently, new ways to account for these benefits have been developed. In fact, the MNR report suggests, "Spatially explicit valuation … could enhance the cost-benefit analysis for large scale projects that impact large areas of land."[18]

While it was outside the scope of this analysis to assess the impacts that a proposed transportation corridor would have on the area's ecosystem services, some high level conclusions can be drawn.

1. Natural capital and the associated flow of ecosystem services within the study area are particularly valuable as a result of high quality natural features in such close proximity to large urban populations who derive significant value from those natural features ($912 million/year).
2. Ignoring such valuable ecosystem services when making land use decision within the study area risks undermining those values that are important, not only to those that live within the study area but also those who live throughout the region.

These conclusions suggest that recommendations for a new transportation corridor should carefully consider the cumulative implications that further disruption and fragmentation will have on the ability of natural processes to function and provide ecosystem benefits. Something that is not currently required in the environmental impact assessment process in Ontario but ought to be if the intent is an objective and comprehensive evaluation of alternatives.

Overall this report emphasizes significant benefits that ecosystem services can provide when natural capital is in close proximity to large urban populations. While the assessment in this report has provided an approximation that admittedly carries some uncertainty, the $912 million per year estimate does provide a sense of the order of magnitude for the natural capital in the MTO WCPA and these values should not be ignored.

[18] Troy, A. And K. Bagstad. (2009). Estimating Ecosystem Services in Southern Ontario. Ontario Ministry of Natural Resources, Toronto, Ontario.

# Appendix: A Brief Overview of Environmental Valuation

**Natural Capital and Ecosystem Services[19]**

Natural capital is the *stock* of natural resources and environmental assets, such as forests, rivers and wetlands that exist in a region at a given point in time. Over time, this natural capital stock yields a *flow* of ecosystem services, such as oil, minerals, water filtration and carbon sequestration.

Ecological services, which provide value to humans, are a direct result of ecosystem composition, structure and function. This means that the variety of elements, the physical and biological components, and the complex interactions between the various organisms and the physical environment in an ecosystem combine to provide goods and services that humans use everyday. For example, the composition, structure and function of a healthy wetland ecosystem can provide water purification, flood control and groundwater recharge services, all of which provide value to humans.

**Total Economic Value**

Economic valuation is anthropocentric and utilitarian[20]. As such, for something to have value in economic analysis it must be of use to humans and impact their welfare. This implies that humans must be aware of, and care for, a stock of natural capital or flow of ecosystem services in order for it to have economic value. While economic valuation does not capture all possible sources of value, the values considered in such an analysis can be broad — much broader than financial or commercial. These include all sources of value that contribute to human well-being, a concept known as total economic value. Total economic value is rooted in the idea that humans may value something, such as an ecosystem service or stock of natural capital, for many different reasons.

There are many different sources of value that contribute to total economic value[21]. These sources of value can be divided into two main categories: use values and non-use (or passive use) values. Use values essentially flow from human interaction with something, such as an ecosystem service or natural capital, while non-use values are derived from the current and future existence of something. Use and non-use values can be further subdivided as shown in Figure 2 below.

Use values include three sub-categories: direct, indirect, and option values. Direct use values result from physical interaction with something and includes both consumptive (e.g.

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[19] This section is adapted from from Kennedy, M. and J. Wilson. (2009). Natural Credit: Assessing the Value of Natural Capital in the Credit River Watershed. Credit Valley Conservation, Mississauga, Ontario.
[20] National Research Council of the National Academies, *Valuing Ecosystem Services: Toward Better Environmental Decision-Making* (Washington, D.C.: The National Academies Press, 2005), 37–38.
[21] Ibid.

timber harvesting) and non-consumptive (e.g. hiking) activities. Indirect use values flow from the support and protection provided by natural capital such as flood control and water purification or other similar ecosystem services. Indirect use values even include the consumption of nature related media (e.g. newspaper articles, television programs, or websites). Option values are essentially future direct and indirect use values.

Non-use values include two sub-categories: existence and bequest values. Existence values result from the knowledge that something exists regardless of human use. Bequest (or preservation) values are derived from the knowledge that something will be available in future generations.

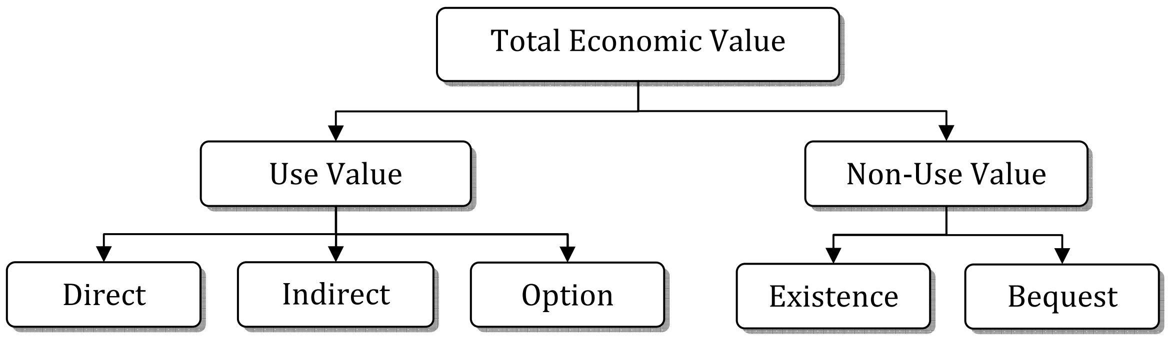


**Figure 2. Total Economic Value**

### Approaches to Valuation

Several different techniques can be used to assign an economic value to natural capital. One option is to use the market price. However, this can only be done if the value of ecosystem services flowing from a particular stock of natural capital is reflected in the market. This is often not the case. The value of many ecosystem services such as habitat provision, and the associated natural capital, is not directly reflected in markets. Therefore, valuing these types of ecosystem services must proceed using non-market valuation approaches. Each approach attempts to assign economic value to natural capital by determining maximum willingness to pay (WTP) or minimum willingness to accept (WTA) for a change in a particular ecosystem service[22]. A notable caveat is that these techniques yield marginal values (i.e. marginal WTP or WTA) for particular changes that reflect human preferences at certain points in time.

Approaches used for non-market valuation include: stated preferences and revealed preferences, which both require original research, as well as value transfers. Stated preference techniques, which gather data on WTP or WTA using surveys, include contingent valuation[23] and attribute-based methods such as choice experiments[24].

[22] Pearce, D.W., G. Atkinson, and S. Mourato. (2006). *Cost-benefit analysis and the environment: recent developments*, Paris: Organisation for Economic Co-operation and Development.
[23] Boyle, K.J. (2003). "Contingent Valuation in Practice," *A Primer on Nonmarket Valuation*, ed. Patricia A. Champ, Kevin J. Boyle and Thomas C. Brown, Netherlands: Kluwer Academic Publishers, p. 111-170.

Revealed preference techniques, which gather data on WTP or WTA by observing an individuals' actual market behaviour, include travel cost[25], hedonic pricing[26], and production function methods[27]. Revealed preferences also include the replacement and treatment cost techniques. While original research is preferred to value transfers, this approach can be used when there are insufficient resources or time to conduct a primary valuation study. This technique involves transferring values from previous studies, in similar situations, already reported in literature[28].

A particular approach to non-market valuation may be better suited to certain contexts or problems than an alternative approach. For example, stated preference approaches are the only techniques capable of capturing non-use values (in addition to use values), as well as valuing changes in ecosystem services that have not occurred. However, stated preference approaches are often criticized for being too hypothetical, among other types of bias[29].

## Background on Value Transfer

More often then not, decision makers are limited by time and money and when decisions have to be made regarding environmental impacts, conducting a primary valuation study is usually not feasible. As a result there is a growing trend to transfer value estimates from a previous study (typically referred to as the study site) with a similar environmental impact to the impact at the policy site (the site of concern to the decision maker). This process of transferring estimates of environmental values is referred to as value transfer (value transfer is also referred to as benefits transfer in some cases).

There are a number of different approaches to transferring values from a study site to the policy site. Previous categorizations of these methods by other authors have all slightly differed[30]. Generally, however, value transfer can be summarized into the following three main approaches as outlined in Table 6.

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[24] Holmes, T.P. and W.L. Adamowicz. (2003). "Attribute-based Methods," *A Primer on Nonmarket Valuation*, ed. Patricia A. Champ, Kevin J. Boyle and Thomas C. Brown, Netherlands: Kluwer Academic Publishers, p. 171-219.
[25] Parsons, G.R. (2003). "The Travel Cost Model," *A Primer on Nonmarket Valuation*, ed. Patricia A. Champ, Kevin J. Boyle and Thomas C. Brown, Netherlands: Kluwer Academic Publishers, p. 269-329.
[26] Taylor, L.O. (2003). "The Hedonic Method," *A Primer on Nonmarket Valuation*, ed. Patricia A. Champ, Kevin J. Boyle and Thomas C. Brown, Netherlands: Kluwer Academic Publishers, p. 331-387.
[27] National Research Council of the National Academies, *Valuing Ecosystem Services: Toward Better Environmental Decision-Making* (Washington, D.C.: The National Academies Press, 2005), 37–38.
[28] Rosenberger, R.S. and J.B. Loomis. (2003). "Benefit Transfer," *A Primer on Nonmarket Valuation*, ed. Patricia A. Champ, Kevin J. Boyle and Thomas C. Brown, Netherlands: Kluwer Academic Publishers, p. 445-482.
[29] Mitchell, R.C. and R. Carson. (1989). *Using Surveys to Value Public Goods: The Contingent Valuation Method*, Washington, D.C.: Resources for the Future.
[30] See Bateman, I., Jones, A., Nishikawa, N. and Brower, R. "Benefits transfer in theory and practice: a review" CSERGE Working Paper GEC 2000-25; and Bergstrom, J.C. and De Civita, P. "Status of Benefits Transfer in the United States and Canada: A Review," Canadian Journal of Agricultural Economics 47 (1999): 79-87; and Groothuis, P. "Benefits Transfer: A comparison of approaches" *Growth and Change* Vol. 36, no. 4 (2005): 551-564.

**Table 6. Summary of value transfer methods**

| Transfer Method | Description |
|---|---|
| Estimate transfer | A simple unit value transfer is the easiest approach. It assumes that the average willingness to pay at the study site is the same at the policy site and the average WTP is directly transferred. The unit value estimate can also be transferring by adjusting the unit value based on expert opinion, or on a re-analysis of a suitable sub-sample of the existing study. |
| Function Transfer | The WTP at the policy site is estimated by transferring the entire benefit function from the study site. By applying the policy site characteristics to the study site's coefficients WTP equation (or benefit function) an estimate of the average WTP at policy site can be determined. Conceptually, this is more appealing than estimate transfer since more information can be transferred. |
| Meta-analysis | Uses many pre-existing primary studies to derive a WTP bid function for a particular ecosystem good or service. A bid function is specified and estimated using regression techniques and the policy site benefit is estimated by applying the regressed coefficients to the values of the policy variables. |