

# ENVIRONMENTAL BENEFIT INDEX FOR WETLAND RESTORATION ON PRIVATE LANDS IN THE GREENBELT REGION OF ONTARIO, CANADA

User Manual



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Possibility grows here.







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## **EXECUTIVE SUMMARY**

In the Greenbelt region, wetlands cover approximately 12% of the area providing multiple ecosystem services worth more than a billion dollars per year. However, the majority of wetlands are held in private ownership and require restoration to maximize their production of ecosystem services. Globally, a wide range of market based instruments have been used to promote restoration and rehabilitation of degraded ecosystems, but reverse auctions have an economic advantage over other instruments because of the competitive bidding process involved.

The design and implementation of reverse auctions is a complex process involving multiple steps. In the Credit River watershed, the initial steps of valuing the ecosystem services provided by wetlands and determining rural landowner's views and preferences for wetland restoration were completed through previous ecosystem valuation and willingness to pay and accept studies (Kennedy and Wilson, 2009; Trenholme *et al*, 2013). This study aims to develop a Greenbelt-specific Environmental Benefit Index (EBI) to be used by conservation practitioners (preferably with experience conducting Ontario wetland evaluations) to measure incremental changes in multiple ecosystem services as a result of private landowners undertaking specific wetland restoration activities.

The Greenbelt-specific wetland restoration EBI was developed utilizing a combination of EBIs developed in the USA, Australia, and Canada and two supporting documents; the CVC Wetland Restoration Strategy (Snell *et al*, 2009) and the Ontario Wetland Evaluation System (OWES, 2013). The preliminary framework included biological, hydrological, and social benefits, and each of these benefits was assigned equal weight. The EBI included 17, 7, and 9 attributes of biological, hydrological, and social benefits, respectively.

The preliminary framework was critically examined and refined by a project Steering Committee comprised of members with expertise in the biological, hydrological and social benefits of wetlands. The refined EBI was presented to the Wetland Restoration EBI Expert Panel, comprised of 12 experts from 11 organizations. The observations/suggestions made by the Expert Panel were later discussed by the Steering Committee, and required modifications were made to the EBI. The modified EBI was tested with three mock projects: (i) wetland enhancement through livestock restriction and buffer, and wetland planting; (ii) wetland creation through disruption of an agricultural tile drain system, and; (iii) wetland type conversion from a

bog to a marsh. The EBI was further refined and finalized on the basis of the results of the three test runs.

The final EBI has three components which include: biological, hydrological, and social benefits. The biological and hydrological components both have two sub-components and the social component has five sub-components. The number of biological, hydrological, and social attributes is 15, 8, and 5, respectively. The Steering Committee felt strongly that both the quality of the existing project site and the quality of the restoration project were factors worth considering in the EBI. Therefore, both the existing condition and the restored condition are assessed separately for each attribute. The maximum number of points to assign each attribute was based on local watershed priorities. The result was that a maximum of 204 and 283 points were assigned to the biological attributes existing condition and restored condition, respectively. A maximum of 315 and 325 points were assigned to the hydrological attributes existing and restored condition, respectively. A maximum of 25 and 125 points were assigned to the social attributes existing and restored condition, respectively. Therefore, the total maximum points attainable in the EBI are 544 and 733 for the existing and restored conditions, respectively.

The total EBI score is the sum of the existing condition score and the change in conditions score (i.e. restored conditions-existing conditions). However, after a careful analysis, it was determined that the existing conditions score and change in conditions score required a weighting of 0.55 for existing condition and 0.45 for change in conditions in order to have the EBI produce the desired results. To calculate the final EBI score the weighted existing conditions score and the weighted change in conditions scores are summed.

An EBI calculator has been developed to assist with the computations involved in the calculation of the final EBI score.

Use of the EBI within a wetland restoration reverse auction program will allow the conservation practitioner to make two determinations: i) which projects to fund based on the biological, hydrological and social benefits provided by the restored wetland, and; ii) which projects to fund based on the cost-to-benefit ratio of each proposed project.

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## **1.0 INTRODUCTION**

The Greenbelt Act (2005) protects approximately 720,000 hectares of environmentally significant lands and farmlands from urban sprawl in Ontario. A Natural Heritage System (NHS) of approximately 219,000 hectares, where the main focus is on protecting, restoring, and reconnecting natural features such as wetlands and woodlands and their functions, is one of the key features of the Greenbelt (Ducks Unlimited Canada et al., 2012). Wetlands cover approximately 96,000 hectares (12%) of land across the Greenbelt and provide ecosystem services worth \$1.3 billion (in 2005\$) per year (David Suzuki Foundation, 2008). More locally, within the Credit River watershed, wetlands were shown to be the most valuable of all natural land types providing at least \$187 million (in 2007\$) per year in ecosystem services to the residents of the watershed (Kennedy and Wilson, 2009).

Land use changes have resulted in the loss of and degradation of the ecosystem services wetlands once provided. The Government of Ontario has created a strong legal and policy framework to protect wetlands in the Greenbelt region. However, infrastructure development, aggregate extraction, intensifying agricultural practices, peat extraction, and water takings still continue to adversely impact wetlands (Ducks Unlimited Canada et al., 2012).

In the Greenbelt region, a high proportion of wetlands are under private ownership. Hence, effective and efficient economic tools such as market-based instruments are required to effectively engage farm and non-farm rural wetland owners in wetland restoration incentive programs delivered at affordable costs. Reverse auctions have advantages over other market-based instruments because the competitive bidding process increases the cost effectiveness of the incentive program.

The design and implementation of a reverse auction is a complex process. Generally, this process is location specific and involves many steps. Key initial steps are to develop: (i) an understanding of the key ecosystem services provided by wetlands and their relative importance to improve the quality of the natural environment for the area; (ii) an understanding of landowners' views on wetland restoration; and (iii) an understanding of economic and environmental preferences of landowners so that an effective incentive program can be designed. In the case of the Credit River watershed, this information was obtained with the completion of two studies funded in part by the Friends of the Greenbelt Foundation. In 2009, Kennedy and Wilson completed a valuation of ecosystem services and in 2013 Trenholm et al.

assessed landowners' views about wetland restoration and their economic and environmental preferences. It was this work that demonstrated the remarkable value of wetlands to society and that a wetland restoration incentive program based on the principles of a reverse auction is the preferred method to restore wetlands on private lands in the Credit River watershed.

In this study, an Environmental Benefit Index (EBI) specific to wetlands and suitable for use within the Greenbelt landscape is developed. In addition, a Microsoft Excel-based Wetland Restoration EBI Calculator is developed to assist in the EBI calculations. Wetlands located in the Credit River watershed are treated as a representative sample of wetlands present across the Greenbelt. Therefore, the EBI is developed for the Credit River watershed but it is applicable to all wetlands across the Greenbelt. The proposed EBI measures environmental as well as social benefits associated with undertaking wetland restoration projects. The EBI serves as a tool for implementing market-based landowner engagement incentive programs - such as reverse auctions – where the measurement of benefits associated with undertaking a specific wetland restoration project is a prerequisite to awarding funding.

In this manual we provide context on how the EBI was developed (Section 2) and present the EBI including the maximum scores, scoring criteria and weighting of each environmental and social attribute (Section 3). In addition, guidance on how to use the Wetland Restoration EBI Calculator Tool is included in Section 4 and concluding remarks are provided in Section 5.

## **2.0 ENVIRONMENTAL BENEFIT INDEX DEVELOPMENT PROCESS**

EBIs that are based on existing local knowledge and/or systems have the most value to conservation practitioners and are able to make the most accurate measurements of ecosystem services. Hence, a review of existing literature on EBIs was conducted prior to initiating the development process. This review included a critical analyses of the EBIs used in the USA, Australia, and Canada. After the review, two supporting key documents; the CVC Wetland Restoration Strategy (Snell *et al*, 2009) and Ontario Wetland Evaluation System (OWES, 2013) were examined. A preliminary framework for an EBI was proposed on the basis of the literature review and the examination of these two documents.

Ontario Wetland Evaluation System (Southern Ontario Manual 3.2, 2013) is based on scientific criteria and was designed to meet the needs of the planning process. The system recognizes the role of wetlands in maintaining critical ecosystem functions as well as providing social benefits. In the system, wetland values are classified into four components: biological, social, hydrological, and special features values. Each component is evaluated individually and separately. Each component is subdivided into sub-components, and some sub-components into attributes and some attributes into sub-attributes. The relative value is assessed by ascribing point scores to predefined values. Within each component, sub-component, attribute and/or sub-attribute, values are weighted to reflect their importance relative to each other. The sum of point scores for sub-attributes and attributes gives a measure of value at the sub-component and component levels. The maximum score for each of the four components is 250, and therefore any wetland can score a maximum of 1000 points.

In the proposal of the preliminary EBI, OWES (2013) was used as the starting point and the components, sub-components, attributes and their scores were modified for their computability and suitability to privately owned wetlands in the Credit River watershed and Greenbelt region. The preliminary EBI framework included three components: biological, hydrological, and social. The relevant attributes of the special feature values component in the OWES were imbedded in the proposed three components. Each of these three components was assigned equal weight of 250. The numbers of attributes were 17 biological, 7 hydrological and 9 social.

A Steering Committee, represented by CVC staff with specialties in all three components of the EBI was formed. The preliminary framework was presented and discussed with the Steering Committee. In this process of refinement, the Steering Committee modified attributes, refined

the weights of components, and revised the scoring mechanisms for each attribute. In addition, the Steering Committee decided that it was important to score wetland benefits for both a change in condition (as a result of the restoration project) and for the quality of the existing (pre-restoration) site. Including both of these elements in the EBI encourages wetland restoration activities that not only provide the greatest amount of improved public benefit as a result of the restoration project, but also encourages wetland restoration to be undertaken in locations where they will have the greatest success at providing long-term benefits. This is based on the ecological concept of it being more efficient to improve and protect the best ecosystems first. In the first refinement of the EBI, the existing site condition and the restored condition were assigned equal weight.

A draft EBI was presented to a group of 12 wetland experts representing 11 organizations. Following this, the observations/suggestions of the Expert Panel were discussed in a Steering Committee meeting, and required enhancements were made to the EBI. The modified EBI was tested with three mock projects: (i) wetland enhancement through livestock restriction and buffer, and wetland planting; (ii) wetland creation through disruption of an agricultural tile drain system, and; (iii) wetland type conversion from a bog to a marsh. This was an invaluable process which resulted in further modifications to the scoring criteria and weights for many of the EBI attributes. The final EBI is presented in Section 3.

### **3.0 ENVIRONMENTAL BENEFIT INDEX**

The final EBI has three components which include: biological, hydrological, and social benefits. The biological and hydrological components each have two sub-components and the social component has five sub-components. The number of biological, hydrological, and social attributes is 15, 8, and 5, respectively. The Steering Committee decided how many points to assign each attribute based on local priorities. The result was that a maximum of 204 and 283 points were assigned to the biological attributes existing condition and restored condition, respectively. A maximum of 315 and 325 points were assigned to the hydrological attributes existing and restored condition, respectively, and a maximum of 25 and 125 points were assigned to the social attributes existing and restored condition, respectively. Therefore, the maximum points attainable in the EBI are 544 and 733 for the existing and restored conditions, respectively.

The complete EBI inclusive of its components, sub-components, attributes, maximum possible scores and scoring criteria is presented in Appendix 1.

### **3.1 MAXIMUM SCORES**

The greater the maximum score, the greater the value that attribute provides to the public and therefore, the greater weight that attribute has in the calculation of the final EBI Score.

Looking to the future, the Steering Committee felt it was important to develop an EBI that measures both the quality of the existing site and the change in condition upon implementation of the wetland restoration project. Including both measures enhances the likelihood that the proposed reverse auction would fund projects that not only provide the greatest amount of improved public benefit but also encourage restoration of sites that are currently fair in quality and that may only require minimal work to unlock their full benefit potential. Valuing the condition of the existing site as well as the change in condition also discourages reverse auction participants from intentionally degrading the quality of their site in an effort to improve the attractiveness of their proposed wetland restoration project. This helps prevent future wetland loss and ensures responsible program spending.

As displayed in the EBI (Appendix 1) a maximum score for both the existing condition and restored condition has been included. For some attributes the maximum score for the existing condition matches that of the restored condition and for others they are different. When the existing condition maximum score is automatically assigned a score of zero this indicates that it is not practical to score the existing condition for that specific attribute. In other instances where the existing condition maximum score is greater than zero but less than the restored condition maximum score, this indicates that it is practical to have existing wetlands in fair condition but that with restoration, an even better score is attainable for that attribute. For instance, when scoring attribute 1.1.8 Carbon Sequestration, a perfect scenario for the existing conditions is having a wetland that is dominated by trees (i.e. a swamp). This would score 15 points out of a maximum of 15 points. However, the proposed wetland restoration project may intend to expand the size of the wetland and plant additional trees in the newly expanded wetland area. This proposed action would result in a score of 25 points out of a maximum of 25 points, representing a change in condition of 10 points. By assigning different maximum scores for the existing and restored conditions, the EBI is able to value additionality benefits for those attributes.

The total maximum points for both the existing and restored condition for each attribute were arrived at through discussions on local priorities held by the Steering Committee and with input

provided by the Wetland Restoration Expert Panel members. For instance, water quality attributes were deemed to be the most important sub-component and as such a total of 200 maximum points (restored condition) was placed on the water quality and carbon storage sub-component, whereas, other sub-components receive fewer total maximum points.

The total maximum EBI points available for the existing condition are 544. This is comprised of 204 from the biological component, 315 from the hydrological component and 25 from the social component.

The total maximum points available for the restored condition are 733. This is comprised of 283 from the biological component, 325 from the hydrological component and 125 from the social component.

The intent of the proposed EBI is to measure public benefits from the restoration of private wetlands and the Steering Committee decided that the provision of public social benefits from private wetlands is limited as compared to biological and hydrological benefits. Hence, the total weight of social benefits for the restored condition only represents 17% of the total maximum points, compared to 39% for biological and 44% for hydrological. It should be noted that ecosystem services such as water and air purification, species biodiversity and flood attenuation are all social benefits that the public receives from wetlands but these have been categorized as biophysical attributes under the biological and hydrological sections of the EBI. Therefore, attributing 17% of the total maximum points to the more direct social component (i.e. recreation, education, etc.) is not viewed as an undervaluing of the social benefits provided by wetlands.

### **3.2 SCORING CRITERIA**

The OWES (2013), as stated earlier, was the starting point for this EBI. Similar, to the identification of components, sub-components, and attributes, the OWES (2013) provided the platform to further refine the scoring criteria for this EBI. However, the scoring criterion of many attributes has been modified to suit the local conditions of private wetlands in the Greenbelt region. The scoring method for each attribute is discussed in this section.

Please note, the heading number convention within this section corresponds to the EBI (Appendix 1) and is not meant to be consistent with the heading number convention used in other sections of this report.

**1.0 Component: Biological**

**1.1 Sub-Component: Wetland Site Characteristics and Biodiversity**

**1.1.1 Attribute: Wetland type**

Wetlands may consist of different wetland ecosystem components such as marshes, swamps, bogs or fens, and similar to OWES (2013), the EBI classifies these as wetland types. Wetland types differ in their physical appearance, types and numbers of plant and animal species present, and rates of primary productivity. The EBI user (conservation practitioner) must determine wetland types based on the major plant species, physical substrate, and hydrological condition of the wetland and immediate surroundings. For detailed guidance on determining wetland type refer to OWES (2013). In this system, shallow open water marshes are simply treated as marsh wetlands.

The OWES values wetland type for its ability to provide primary productivity and therefore marshes are scored highest followed by swamps, fens and lastly bogs. The Steering Committee decided to deviate from this logic and score wetland type based on rarity within the Greenbelt region. As a result, bogs and fens are ranked highest followed by swamps and then marshes.

The wetland type EBI scoring criteria for the existing and restored wetland conditions are provided in table 1.1.1.

**Table 1.1.1 Weights and Scoring Criteria for Wetland Types**

<b>Existing Condition - Scoring Criteria Maximum Score – 10</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 10</b>
<ul style="list-style-type: none"> <li>- Zero points for no existing wetland</li> <li>- Fractional Area x 5 points for marsh</li> <li>- Fractional Area x 8 points for swamp</li> <li>- Fractional Area x 10 points for bog and/or fen</li> </ul>	<ul style="list-style-type: none"> <li>- Fractional Area x 5 points for marsh</li> <li>- Fractional Area x 8 points for swamp</li> <li>- Fractional Area x 10 points for bog and/or fen</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- The Fractional Area (FA) of all wetlands must equal 1, regardless of whether or not there are multiple wetland types present. For example, a wetland that only contains marsh would have a score of 5 points (FA(1) x 5 = 5 points), however, a wetland that contains 50% swamp and 50% bog would have a score of 9 points (FA(0.5) x 8 = 4 points swamp and FA(0.5) x 10 = 5 points bog, totaling 9 points).</li> <li>- Scores must be recorded as whole numbers. If necessary, use standard rounding rules to calculate final score (i.e. 7.5 is recorded as 8 and 7.4 is recorded as 7).</li> </ul>	

**1.1.2 Attribute: Effective Project Area**

The effective project area is the area of wetland created or enhanced as a result of the restoration project. The wetland area is measured out to the high water mark or to the point where there is less than 50% wetland vegetation, whichever is greater. The effective project area is an important component of restoration projects because the larger a wetland restoration project area, the more likely it will provide multiple ecosystem benefits such as biodiversity and wildlife habitat. Hence, a minimum score of 2 is assigned for projects smaller than 0.5 hectares and a maximum score of 20 is assigned to projects greater than or equal to 10 hectares. Because this attribute specifically relates to the change in wetland size as a result of the restoration project, the existing condition is not scored and automatically awarded zero points. The effective project area EBI weights and scoring criteria for the existing and restored conditions are provided in table 1.1.2.

**Table 1.1.2 Weights and Scoring Criteria for Effective Project Area**

Existing Condition - Scoring Criteria Automatic Score - zero	Restored Condition - Scoring Criteria Maximum Score – 20
- Not applicable	<ul style="list-style-type: none"> <li>- 2 points for less than 0.5 hectare</li> <li>- 5 points for greater than or equal to 0.5 hectare but less than 2 hectares</li> <li>- 10 points for greater than or equal to 2 hectares but less than 5 hectares</li> <li>- 15 points for greater than or equal to 5 hectares but less than 10 hectares</li> <li>- 20 points for greater than or equal to 10 hectares</li> </ul>
Note: - The wetland area is measured from the high water mark or to the point where there is less than 50% wetland vegetation, whichever is greater	

### **1.1.3 Attribute: Proximity to Other Wetlands**

Habitat connectivity is a biological attribute provided by wetlands. Proximity and connectivity to other wetlands provide more favorable habitat for wildlife species. Wetland proximity can be very important for smaller size wetlands and specifically when these smaller wetlands meet the specialized needs of sensitive wildlife species. The relative weights for the presence of another wetland are assigned on the basis of the distance between another wetland and the restoration project. The distance is to be measured from the outer boundary line of the wetlands. The proximity to other wetlands EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.3

**Table 1.1.3 Weights and Scoring Criteria for Proximity to Other Wetlands**

<b>Existing Condition - Scoring Criteria Maximum Score – 10</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 10</b>
<ul style="list-style-type: none"><li>- 4 points for no wetland within 120m of the restoration project</li><li>- 6 points for a wetland that exists within 30-120 m of the restoration project</li><li>- 8 points for a wetland that exists within 10 – 29 m of the restoration project</li><li>- 10 points for a wetland that exists less than 10 m from the wetland restoration project</li></ul>	<ul style="list-style-type: none"><li>- 4 points for no wetland within 120m of the restoration project</li><li>- 6 points for a wetland that exists within 30-120 m of the restoration project</li><li>- 8 points for a wetland that exists within 10 – 29 m of the restoration project</li><li>- 10 points for a wetland that exists less than 10 m from the wetland restoration project</li></ul>

**1.1.4 Attribute: Permanent and Seasonal Open Water Types**

Open water areas contribute to the overall habitat diversity and the quality of a wetland. The aerial configuration and relative proportion of open water spaces is very important to many wildlife species. For example, many waterfowl species use islands and irregular shorelines for feeding, nesting, and resting. Hence, the percentage as well as the pattern of open water is assessed. Please note that: (i) open water types include the presence of streams and rivers within the wetland limits; (ii) permanent open water is year round standing water with or without emergent vegetation; (iii) seasonal open water includes intermittent watercourses and vernal pools that contain ponded water for greater than 2 months of the year; and (iv) when assessing open water do not include areas with vegetation so dense that a duck could not swim through it. The open water types EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.4. If necessary, the conservation practitioner may refer to the OWES (2013) for further details on this attribute.

**Table 1.1.4 Weights and Scoring Criteria for Open Water Types**

Existing Condition - Scoring Criteria Maximum Score – 10	Restored Condition - Scoring Criteria Maximum Score - 10
<ul style="list-style-type: none"> <li>- Zero points for no permanent or seasonal open water</li> <li>- 2 points for more than 95% of the area as permanent open water</li> <li>- 4 points for less than 5% of the area as permanent open water and/or less than 5% of the area as seasonal open water</li> <li>- 4 points for 5-25% of area as permanent open water and it is occurring in the central portion of wetland</li> <li>- 4 points for 76-95% of area as permanent open water, occurring in large central area; vegetation is peripheral</li> <li>- 6 points for 5-25% of area as permanent open water, occurring in various sized ponds; vegetation in dense patches or diffuse open stands</li> <li>- 6 points for 76-95% of area as permanent open water; vegetation occurs in patches or diffuse open stands</li> <li>- 8 points for 26-75% of area as permanent open water, occurring in central portion of wetland</li> <li>- 10 points for 26-75% of area as permanent open water, occurring in pattern of small ponds; embayments are common and/or 6-100% of area as seasonal open water.</li> </ul>	<ul style="list-style-type: none"> <li>- Zero points for no permanent or seasonal open water</li> <li>- 2 points for more than 95% of the area as permanent open water</li> <li>- 4 points for less than 5% of the area as permanent open water and/or less than 5% of the area as seasonal open water</li> <li>- 4 points for 5-25% of area as permanent open water and it is occurring in the central portion of wetland</li> <li>- 4 points for 76-95% of area as permanent open water, occurring in large central area; vegetation is peripheral</li> <li>- 6 points for 5-25% of area as permanent open water, occurring in various sized ponds; vegetation in dense patches or diffuse open stands</li> <li>- 6 points for 76-95% of area as permanent open water; vegetation occurs in patches or diffuse open stands</li> <li>- 8 points for 26-75% of area as permanent open water, occurring in central portion of wetland</li> <li>- 10 points for 26-75% of area as permanent open water, occurring in pattern of small ponds; embayments are common and/or 6-100% of area as seasonal open water.</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Open water includes the presence of streams and rivers within the wetland limits.</li> <li>- Permanent open water is year round standing water with or without emergent vegetation.</li> <li>- Seasonal open water includes intermittent watercourses and vernal pools that contain ponded water for greater than 2 months of the year.</li> <li>- When assessing open water do not include areas with vegetation so dense that a duck could not swim through it.</li> </ul>	

### **1.1.5 Attribute: Interspersion**

Many wildlife species prefer the “edge” areas between different types of habitat, and therefore the number of species and the population density of many species is often highest in these zones. Interspersion is a measure of the amount of edge and is an important component to consider when planning a wetland restoration project. Following the OWES (2013) method, interspersion is measured by completing the following steps:

1. Develop a map of the wetland showing the wetland boundary and the vegetation communities.
2. Measure the longest distance of the wetland from boundary to boundary (i.e. high water mark or to the point where there is less than 50% wetland vegetation, whichever is greater).
3. Divide this distance by 12 and draw a square grid covering the wetland.
4. Count the number of times the horizontal and vertical grid lines intersect a wetland or vegetation community boundary. When an intersection occurs at the location where the horizontal and vertical gridlines meet this is counted as two intersections.

If further instruction is required, consult the OWES (2013). The interspersion EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.5.

**Table 1.1.5 Weights and Scoring Criteria for Interspersion**

<b>Existing Condition - Scoring Criteria Maximum Score – 10</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 10</b>
- 2 point for less than 20 intersections	- 2 point for less than 20 intersections
- 4 points for 21-30 intersections	- 4 points for 21-30 intersections
- 6 points for 31-40 intersections	- 6 points for 31-40 intersections
- 8 points for 41-50 intersections	- 8 points for 41-50 intersections
- 10 points for greater than 50 intersections	- 10 points for greater than 50 intersections

**1.1.6 Attribute: Vegetation Communities on the Site**

A vegetation community is defined as a group of plant species occupying a specific area. The number of vegetation communities is a good measure of biodiversity, and an important aspect of the landscape. Hence, restoration and enhancement of vegetation communities are important aspects of wetland restoration projects. Local Ecological Land Classification mapping (GIS data set available here: <https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home>) may be used to define vegetation communities on the site. Similar to OWES (2013), the EBI recognizes the value of both vegetation communities and forms. Forms are the physical structure or shape of a plant. There are 16 vegetation forms recognized for wetlands and these include:

- |                          |                              |
|--------------------------|------------------------------|
| 1. Deciduous trees       | 9. Mosses                    |
| 2. Coniferous trees      | 10. Robust emergent          |
| 3. Dead deciduous trees  | 11. Narrow leaved emergent   |
| 4. Dead coniferous trees | 12. Broad leaved emergent    |
| 5. Tall shrubs           | 13. Floating plants (rooted) |
| 6. Low shrubs            | 14. Free floating plants     |
| 7. Dead shrubs           | 15. Submerged plants         |
| 8. Herbs (ground cover)  | 16. No vegetation            |

Each vegetation community may contain one or several combinations of vegetation forms, and therefore we propose a scoring system, similar to OWES (2013), based on the number of vegetation communities and vegetation forms. The vegetation communities EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.6.

**Table 1.1.6 Weights and Scoring Criteria for Vegetation Communities**

Existing Condition - Scoring Criteria Maximum Score - 45		Restored Condition - Scoring Criteria Maximum Score - 45	
# of communities with 1-3 forms	# of communities with 4-5 forms	# of communities with 1-3 forms	# of communities with 4-5 forms
1 = 1.5 points	1 = 2 points	1 = 1.5 points	1 = 2 points
2 = 2.5 points	2 = 3.5 points	2 = 2.5 points	2 = 3.5 points
3 = 3.5 points	3 = 5 points	3 = 3.5 points	3 = 5 points
4 = 4.5 points	4 = 6.5 points	4 = 4.5 points	4 = 6.5 points
5 = 5 points	5 = 7.5 points	5 = 5 points	5 = 7.5 points
6 = 5.5 points	6 = 8.5 points	6 = 5.5 points	6 = 8.5 points
7 = 6 points	7 = 9.5 points	7 = 6 points	7 = 9.5 points
8 = 6.5 points	8 = 10.5 points	8 = 6.5 points	8 = 10.5 points
9 = 7 points	9 = 11.5 points	9 = 7 points	9 = 11.5 points
10 = 7.5 points	10 = 12.5 points	10 = 7.5 points	10 = 12.5 points
11 = 8 points	11 = 13 points	11 = 8 points	11 = 13 points
+ 0.5 for each additional	+ 0.5 for each additional	+ 0.5 for each additional	+ 0.5 for each additional

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community	community	community	community
Note: - Sum all community scores together to calculate the final score. For example, a wetland with 3 x one form communities, 4 x two form communities and 2 x five form community would score 10 points (i.e. 7 x 1-3 forms = 6 points + 2 x 4-5 forms = 3.5 points = 9.5 points which would round-up to 10 points)			

**1.1.7 Attribute: Diversity of the Surrounding Habitat**

Not only is the diversity of the wetland an important consideration for wildlife habitat, so too is the diversity of the wetlands surrounding habitat. Many wildlife species use both upland habitat and wetland habitat during their life cycles. Similar to the OWES (2013), the EBI measures the diversity of the surrounding habitat based on the number of ecological land classifications present within 120 metres of the wetland boundary. The diversity of surrounding habitat EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.7.

**Table 1.1.7 Weights and Scoring Criteria for Diversity of Surrounding Habitat**

Existing Condition - Scoring Criteria Maximum Score - 10	Restored Condition - Scoring Criteria Maximum Score - 10
(check all appropriate items)  For each surrounding habitat type assign 1 point to a maximum of 10 points _ non-intensive agriculture (hay/pasture) _ abandoned agricultural land _ deciduous forest _ coniferous forest _ mixed forest _ abandoned pits and quarries _ open lake or deep river _ terrain appreciably undulating, hilly or with ravines _ creek flood plain _ grassland	(check all appropriate items)  For each surrounding habitat type assign 1 point to a maximum of 10 points _ non-intensive agriculture (hay/pasture) _ abandoned agricultural land _ deciduous forest _ coniferous forest _ mixed forest* _ abandoned pits and quarries _ open lake or deep river _ terrain appreciably undulating, hilly or with ravines _ creek flood plain _ grassland
Notes: - Assess this attribute for the area within 120m of the restored wetland boundary. - Mixed forest defined as either 25% coniferous trees distributed singularly or in clumps in deciduous forest, or 25% deciduous trees distributed singly or in clumps in coniferous forest.	

**1.1.8 Attribute: Carbon Sequestration**

Carbon sequestration is the process of atmospheric carbon capture and long-term storage in plant biomass. All vegetation types capture carbon through photosynthesis but the amount of carbon sequestered depends in part on bio-physical features of the vegetation. In general, trees capture more carbon than grasses and grasses capture more carbon than aquatic vegetation. The carbon sequestration EBI weights and scoring criteria for existing and restored conditions are provided in table 1.1.8.

**Table 1.1.8 Weights and Scoring Criteria for Carbon Sequestration**

Existing Condition - Scoring Criteria Maximum Score – 15	Restored Condition - Scoring Criteria Maximum Score - 25
<ul style="list-style-type: none"> <li>- 5 points for aquatic dominated vegetation</li> <li>- 10 points for grass/forb dominated vegetation</li> <li>- 15 points tree dominated vegetation</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if no plantings are planned as part of the proposed wetland project</li> <li>- Add 5 points to existing condition score if aquatic vegetation will be planted</li> <li>- Add 8 points to existing condition score if grass/forbs will be planted</li> <li>- Add 10 points to existing condition score if trees will be planted</li> </ul>
<p>Note:</p> <ul style="list-style-type: none"> <li>- For the existing condition, choose the option that best represents the project location (i.e. wetland and natural buffer area)</li> <li>- For the restored condition, add points until a maximum of 25 is reached</li> </ul>	

## 1.2 Sub-Component: Wildlife and Wildlife Habitat

Wildlife habitat is an ecosystem function provided by wetlands, and the value of a wetland from a wildlife habitat perspective is strongly tied to the biological condition of the wetland. Therefore, the wildlife habitat sub-component is included within the biological component of the EBI, and we identify seven attributes that collectively measure the wildlife habitat value of wetlands. Each attribute is described in greater detail below.

### 1.2.1 Attribute: Reproductive Habitat for Endangered and/or Threatened Species

Endangered and threatened species and their habitats have been provided with protection under provincial legislation. Some endangered and threatened species depend on wetlands for reproduction and wetland restoration projects that improve this function are encouraged. The reproductive habitat for endangered and/or threatened species EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.1.

**Table 1.2.1 Weights and Scoring Criteria for Reproductive Habitat for Endangered and/or Threatened Species**

Existing Condition - Scoring Criteria Maximum Score – 12	Restored Condition - Scoring Criteria Maximum Score - 24
<ul style="list-style-type: none"> <li>- zero points for no record of endangered or threatened species reproducing in the existing wetland or no wetland currently exists</li> <li>- 6 points for confirmed reproductive use of the existing wetland by one endangered and/or threatened species</li> <li>- 12 points for confirmed reproductive use of the existing wetland by more than one endangered and/or threatened species</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if there is no predicted reproductive benefit to endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 6 points to existing condition score if there is a predicted reproductive benefit to one endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 12 points to existing condition score if there is a predicted reproductive benefit to more than one endangered or threatened species as a result of the wetland restoration project</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of species at risk</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Species at risk recovery strategies are to be used to validate likelihood that the proposed project will have a reproductive benefit to species at risk</li> </ul>	

**1.2.2 Attribute: Traditional Migration, Feeding or Hibernation Habitat for Endangered and/or Threatened Species**

The survival of endangered and threatened species depends on the presence of suitable habitat along the migration route, feeding habitat and hibernation habitat, where applicable. Hence, traditional migration, feeding and hibernation areas (not necessarily breeding habitat) are critical for the protection of many endangered and/or threatened species. Similar, to the reproductive habitat attribute, this attribute is also scored as per the number of endangered and/or threatened species using the project area for migration, feeding and hibernation purposes. The migration, feeding or hibernation habitat for endangered and/or threatened species EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.2.

**Table 1.2.2 Weights and Scoring Criteria for Traditional Migration, Feeding or Hibernation Habitat for Endangered and/or Threatened Species**

Existing Condition - Scoring Criteria Maximum Score – 12	Restored Condition - Scoring Criteria Maximum Score - 24
<ul style="list-style-type: none"> <li>- zero points for no record of endangered or threatened species utilizing the existing wetland for migration, feeding or hibernating in the existing wetland or no wetland currently exists</li> <li>- 6 points for confirmed use of the existing wetland for migration, feeding and hibernating by one endangered and/or threatened species</li> <li>- 12 points for confirmed use of the existing wetland for migration, feeding and hibernating by more than one endangered and/or threatened species</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if there is no predicted migration, feeding and hibernating benefit to endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 6 points to existing condition score if there is a predicted migration, feeding and/or hibernating benefit to one endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 12 points to existing condition score if there is a predicted migration, feeding and/or hibernating benefit to more than one endangered or threatened species as a result of the wetland restoration project</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of species at risk</li> <li>- Record must be no more than 20 years old to be considered valid.</li> <li>- Species at risk recovery strategies are to be used to validate the likelihood that the proposed project will have a migration, feeding and/or hibernation benefit to species at risk</li> </ul>	

**1.2.3 Attribute: Presence of Locally, Regionally, and/or Provincially Significant Plant and Animal Species that Directly Benefit from Existence of Wetlands**

Provincially significant species are determined by the Natural Heritage Information Centre (NHIC). There is conservation concern at a global, national or provincial level for certain provincially significant species. These species include individual species or assemblages of species (e.g. plant communities or wildlife concentration areas) and federally or provincially listed species at risk including listed populations or designatable units (genetically, geographically, etc.) of a specific species. One important aspect of these species is that “fauna” in this section includes invertebrates. It is recommended that NHIC lists for provincially significant species be consulted early on in the wetland restoration planning process to gain familiarity with the rare species that may be present in the project area. The presence of locally and regionally rare plant and animal species can often be obtained from the local conservation authority. Similar to the two previous attributes, 1.2.1 and 1.2.2, this attribute is scored as per the number of these species reported in the project area. The presence of locally, regionally, and/or provincially significant plant and animal species EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.3.

**Table 1.2.3 Weights and Scoring Criteria for Presence of Locally, Regionally, and/or Provincially Significant Plant and Animal species**

Existing Condition - Scoring Criteria Maximum Score – 20	Restored Condition - Scoring Criteria Maximum Score - 30
<ul style="list-style-type: none"> <li>- zero points for no locally, regionally, and/or provincially significant plant or animal species within 120m of the effective project area</li> <li>- 10 points for one locally, regionally, and/or provincially significant plant or animal species within 120 m of the effective project area</li> <li>- 20 points for more than one locally, regionally, and/or provincially significant plant and/or animal species within 120 m of the effective project area</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if the project is not anticipated to benefit a locally, regionally and/or provincially significant plant or animal species.</li> <li>- Add 5 points to existing condition score if the project is anticipated to benefit one locally, regionally and/or provincially significant plant or animal species.</li> <li>- Add 10 points to existing condition score if the project is anticipated to benefit more than one locally, regionally, and/or provincially significant plant and/or animal species.</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of significant species</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Where available, species at risk strategies or other documents are to be used to validate the likelihood that the proposed project will have a benefit to any locally, regionally, and/or provincially significant species</li> </ul>	

**1.2.4 Attribute: Nesting and Feeding Habitat for Colonial Waterbirds**

Colonial waterbirds indicate a special type of secondary and tertiary productivity. The nesting of these birds is localized but it is of special interest to many people and the colonies are quite vulnerable to destruction. Some wetland areas, while not used for nesting, are regularly used as feeding areas by the members of a nearby colony. Colonial wetland-dependent nesting birds that can be scored under this section are: Red-necked Grebe, Black-crowned Night Heron, Great Egret, Black Tern, Caspian Tern, Common Tern, and Great Blue Heron. The Great Blue Heron is scored only for nesting occurrences because they can be found feeding in nearly all wetlands in southern Ontario (OWES, 2013). The nesting and feeding habitat for colonial waterbirds EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.4.

**Table 1.2.4 Weights and Scoring Criteria for Nesting and Feeding Habitat for Colonial Waterbirds**

<b>Existing Condition - Scoring Criteria Maximum Score – 10</b>	<b>Restored Condition - Scoring Criteria Maximum Score -15</b>
<ul style="list-style-type: none"> <li>- Zero points for not known or not possible (i.e. no open water) to have fed or nested</li> <li>- 4 points for active feeding area (except great blue heron)</li> <li>- 7 points for known to have nested within the past 5 years</li> <li>- 10 points for currently nesting colony</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no improved benefit to nesting and feeding habitat for colonial waterbirds as a result of the wetland restoration project</li> <li>- Add 5 points to existing condition score for improvement to the nesting and/or feeding habitat for colonial waterbirds as a result of the wetland restoration project</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Only the following wetland dependent colonial waterbirds are eligible to be scored: red-necked grebe, black-crowned night heron, great egret, black tern, caspian tern, common tern and great blue heron (scored for nesting only).</li> <li>- Local records to be used to validate feeding/nesting of colonial waterbirds..</li> <li>- Record must be no more than 20 years old to be considered valid.</li> <li>- Where available, documents are to be used to validate the likelihood that the proposed project will have a benefit to colonial waterbirds.</li> </ul>	

**1.2.5 Attribute: Waterfowl Breeding, Staging and/or Moulting Area**

In the case of waterfowl, staging and moulting areas are also important in addition to breeding areas. A ‘staging area’ is an area where birds that migrate in flocks rest and feed either immediately before or during migration. A ‘moulting area’ is an area that waterfowl use to shed old feathers. These areas are important because during this period waterfowl are often unable to fly and are susceptible to predation. The scoring mechanism for this attribute is based on the scale of significance (i.e. local, watershed or provincially significant). The waterfowl breeding, staging and/or moulting area EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.5. .

**Table 1.2.5 Weights and Scoring Criteria for Waterfowl Breeding, Staging, and/or Moulting Area**

Existing Condition - Scoring Criteria Maximum Score -10	Restored Condition - Scoring Criteria Maximum Score - 15
<ul style="list-style-type: none"> <li>- Zero points for no evidence of waterfowl breeding, staging and/or moulting or no wetland currently exists</li> <li>- 2 points for evidence of waterfowl breeding, staging and/or moulting at any scale</li> <li>- 4 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered locally significant</li> <li>- 7 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered watershed significant</li> <li>- 10 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered provincially significant</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no increase in wetland area</li> <li>- Add 2 points to existing condition score for an increase in wetland area of up to 0.5 hectares</li> <li>- Add 3 points to existing condition score for an increase in wetland area of more than 0.5 hectares but less than 2 hectares</li> <li>- Add 5 points to existing condition score for an increase in wetland area greater than or equal to 2 hectares.</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate significance of waterfowl breeding, staging and/or moulting area</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Geese are not considered an eligible species of waterfowl to score. Wetland restoration designs intended to benefit geese are not encouraged.</li> </ul>	

**1.2.6 Attribute: Migratory Passerine, Shorebird, or Raptor Stopover Area**

All wetlands have some significance as migratory bird stopover areas and a few, such as certain wetlands along the north shores of Lakes Erie and Ontario in particular, are places where passerines and/or shorebirds in great numbers stop to rest and feed for short periods during migration. The scoring mechanism for this attribute is based on the scale of significance (i.e. local, watershed, provincially significant). The migratory passerine, shorebird, or raptor stopover area EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.6.

**Table 1.2.6 Weights and Scoring Criteria for Migratory Passerine, Shorebird, or Raptor Stopover Area**

<b>Existing Condition - Scoring Criteria Maximum Score – 10</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 15</b>
<ul style="list-style-type: none"> <li>- Zero points for no evidence of existing wetland being used for stopover habitat by migratory passerine, shorebird, or raptors or no wetland currently exists</li> <li>- 2 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat at any scale</li> <li>- 4 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered locally significant</li> <li>- 7 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered watershed significant</li> <li>- 10 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered provincially significant</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no increase in wetland area</li> <li>- Add 2 points to existing condition score for an increase in wetland area of up to 0.5 hectares</li> <li>- Add 3 points to existing condition score for an increase in wetland area of more than 0.5 hectares but less than 2 hectares</li> <li>- Add 5 points to existing condition score for an increase in wetland area greater than or equal to 2 hectares</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate significance of migratory passerine, shorebird, or raptor stopover area</li> <li>- Record must be no more than 20 years old to be considered valid</li> </ul>	

**1.2.7 Attribute: Fish Habitat**

As per the Fisheries Act, fish habitat includes spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly on in order to carry out their life processes. Wetland fish habitat is usually found in marsh and swamp wetland types, although fens have also been documented as providing spawning habitat in some instances. The area and quality of fish habitat can vary considerably from a small area in an isolated wetland that supports one or two species, to a large wetland that supports a great diversity of fish species. The EBI scores the quality of fish habitat based on the habitat duration (i.e. seasonal or permanent) and whether or not piscivores (fish that eat other fish) are present. The fish habitat EBI weights and scoring criteria for existing and restored conditions are provided in table 1.2.7.

**Table 1.2.7 Weights and Scoring Criteria for Fish Habitat**

Existing Condition - Scoring Criteria Maximum Score – 20	Restored Condition – Scoring Criteria Maximum Score - 20
<ul style="list-style-type: none"> <li>- Zero points for no existing fish habitat</li> <li>- Fractional Area of wetland feature x 3 points for seasonal habitat without piscivores</li> <li>- Fractional Area of wetland feature x 8 points for seasonal habitat with piscivores</li> <li>- Fractional Area of wetland feature x 15 points for permanent habitat without piscivores</li> <li>- Fractional Area of wetland feature x 20 points for permanent habitat with piscivores</li> </ul>	<ul style="list-style-type: none"> <li>- Fractional Area of wetland feature x 3 point for seasonal habitat predicted to not have piscivores</li> <li>- Fractional Area of wetland feature x 8 points for seasonal habitat predicted to have piscivores</li> <li>- Fractional Area of wetland feature x 15 points for permanent habitat predicted to not have piscivores</li> <li>- Fractional Area of wetland feature x 20 points for permanent habitat predicted to have piscivores</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- The Fractional Area (FA) of all wetlands must equal 1, regardless of whether or not there are multiple wetland types present</li> <li>- Scores must be recorded as whole numbers. If necessary, use standard rounding rules to calculate final score (i.e. 7.5 is recorded as 8 and 7.4 is recorded as 7).</li> <li>- When calculating FA only include the area up to the high water mark</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- <i>Piscivores</i>: fish that eat other fish</li> <li>- Fish stocking is not regarded as a wetland restoration activity</li> </ul>	

## **2.0 Component: Hydrological**

The hydrological component captures the role wetlands plays in the maintenance, control, and/or modification of the quantity and quality of water passing through a drainage basin. The hydrological component is designed to determine the net hydrological benefit provided by a specific wetland to the portion of the basin downstream of the wetland.

To assess the hydrological function of a wetland, it must be evaluated relative to its role in the drainage basin where it is located and the hydrological setting in that specific drainage basin. The component has two sub-components; each component and associated attributes are described in detail below.

### **2.1 Sub-Component: Flood Attenuation and Ground Water Recharge/Discharge**

#### **2.1.1 Attribute: Flood Attenuation Capacity**

Flood protection for areas downstream of wetlands is an important ecological service provided by wetlands. Wetlands reduce storm floods by temporarily holding back water and by allowing a space for surface water to seep into the ground where it may recharge groundwater supplies and/or be transpired by vegetation. This water would otherwise flow quickly downstream and in some instances causing flooding. This attribute is scored on the potential flood water generation of the catchment upstream of the wetland and the flood water retention capacity of the wetland. The flood attenuation capacity EBI weights and scoring criteria for existing and restored conditions are provided in table 2.1.1.

**Table 2.1.1 Weights and Scoring Criteria for Flood Attenuation Capacity**

<b>Existing Condition - Scoring Criteria Maximum Score – 75</b>	<b>Restored Condition - Scoring Criteria Maximum Score – 75</b>
<p>Step #1: Determine flood volume generated by upstream catchment area under a 5, 10, 25, 50 and 100 year design storm–return period.</p> <p>Volume= Area (ha) x Runoff Coefficient (dimensionless) x Rainfall Amount (mm)</p> <p>Where:</p> <ul style="list-style-type: none"> <li>- Area = catchment area upstream of proposed project site. Note: the use of GIS mapping programs facilitates this process.</li> <li>- Runoff Coefficient= 0-1 rating depending on extent of imperviousness of upstream catchment area. See Appendix 2 for a table and description on how to calculate this value.</li> <li>- Rainfall Amount= a fixed amount of rainfall expected for specific design storm events. These rainfall</li> </ul>	<p>Step #1: Determine flood volume generated by upstream catchment area under a 5, 10, 25, 50 and 100 year design storm–return period.</p> <p>Volume= Area (ha) x Runoff Coefficient (dimensionless) x Rainfall Amount (mm)</p> <p>Where:</p> <ul style="list-style-type: none"> <li>- Area = catchment area upstream of proposed project site. Note: the use of GIS mapping programs facilitates this process.</li> <li>- Runoff Coefficient= 0-1 rating depending on extent of imperviousness of upstream catchment area. See Appendix 2 for a table and description on how to calculate this value.</li> <li>- Rainfall Amount= a fixed amount of rainfall expected for specific design storm events. These</li> </ul>

amounts are determined utilizing the Ministry of Transportation of Ontario (MTO) online tool found here:  
[http://www.mto.gov.on.ca/IDF\\_Curves/terms.shtml](http://www.mto.gov.on.ca/IDF_Curves/terms.shtml)  
 Note: copy the rainfall amount values found in Row A of the MTO online tool and place them under the corresponding design storm–return period in the table below:

Design Storm – Return Period	5 year	10 year	25 year	50 year	100 year
Rainfall Amount					

Step #2: Calculate the maximum available flood volume storage of the existing wetland (if one exists).

$$\text{Volume} = (a_1 + a_2 / 2) \times H$$

Where:

Volume= total potential wetland flood water storage  
 $a_1$ = area of wetland base  
 $a_2$ = area of wetland high water mark  
 H = depth of water when at high water boundary of wetland

Step #3: Score wetland flood attenuation capacity

Compare Volumes calculated in Step #1 to the Volume calculated in Step #2 to determine the design storm flood attenuation capacity of the existing wetland. Note: the design storm flood attenuation capacity is the greatest design storm where the Volume calculated in Step #2 (wetland storage) is greater than the Volume calculated in Step #1 (runoff generated). If the wetland storage volume is less than the runoff amount generated at a specific design storm, the wetland is unable to attenuate all of these flows.

Design Storm – Return Period	2-5 year	10 year	25 year	50 year	100 year	Total
	15 points	75 points				

rainfall amounts are determined utilizing the Ministry of Transportation of Ontario (MTO) online tool found here:  
[http://www.mto.gov.on.ca/IDF\\_Curves/terms.shtml](http://www.mto.gov.on.ca/IDF_Curves/terms.shtml)  
 Note: copy the rainfall amount values found in Row A of the MTO online tool and place them under the corresponding design storm–return period in the table below:

Design Storm – Return Period	5 year	10 year	25 year	50 year	100 year
Rainfall Amount					

Step #2: Calculate the maximum available flood volume storage of the proposed wetland.

$$\text{Volume} = (a_1 + a_2 / 2) \times H$$

Where:

Volume= total potential wetland flood water storage  
 $a_1$ = area of wetland base  
 $a_2$ = area of wetland high water mark  
 H = depth of water when at high water boundary of wetland

Step #3: Score wetland flood attenuation capacity

Compare Volumes calculated in Step #1 to the Volume calculated in Step #2 to determine the design storm flood attenuation capacity of the proposed wetland. Note: the design storm flood attenuation capacity is the greatest design storm where the Volume calculated in Step #2 (wetland storage) is greater than the Volume calculated in Step #1 (runoff generated). If the wetland storage volume is less than the runoff amount generated at a specific design storm, the wetland is unable to attenuate all of these flows.

Design Storm – Return Period	2-5 year	10 year	25 year	50 year	100 year	Total
	15 points	75 points				

Notes:

- This calculation assumes that the wetland is storing no water at the time of a runoff event and is therefore based on maximum potential flood water attenuation.
- Example Calculation: If a wetland has a storage capacity of up to the 50 year design storm event the score for this wetland would be 60 points (i.e. 15+15+15+15 points).

### 2.1.2 Attribute: Groundwater Discharge

Groundwater discharging into a wetland is typically nutrient and mineral rich allowing for the development of locally unique ecosystems and improvements to overall biodiversity. The ecological consequences of such discharge are reflected in the attributes of the biological component. In the hydrology component, the water quality and quantity improvement as a result of groundwater discharge is captured. Generally, it is assumed that the groundwater which emerges in a wetland is of better quality as compared to if the wetland was not present due to the filtering effects of wetland soils, flora and microorganisms. Groundwater discharge wetlands are valuable during dry periods when there is little surface runoff occurring. Discharging wetlands maintain base flows in receiving watercourses long-after surface runoff ceases. The accurate measurement of ground water discharge contributions is complex, and therefore similar to OWES (2013), a number of wetland characteristics are used as groundwater discharge indicators in an effort to score the value of this attribute. The ground water discharge EBI weights and scoring criteria for existing and restored conditions are provided in table 2.1.2. For further explanation of the wetland characteristics, please refer to OWES (2013).

**Table 2.1.2 Weights and Scoring Criteria for Groundwater Discharge**

Existing Condition - Scoring Criteria Maximum Score – 25				Restored Condition - Scoring Criteria Maximum Score - 25			
Wetland Characteristic	None to Little	Some	High	Wetland Characteristic	None to Little	Some	High
Dominant Wetland Type	Bog = 0	Swamp/Marsh = 2	Fen = 5	Dominant Wetland Type	Bog = 0	Swamp/Marsh = 2	Fen = 5
Topography	Flat/rolling = 0	Hilly = 2	Steep = 5	Topography	Flat/rolling = 0	Hilly = 2	Steep = 5
Wetland area: upslope catchment area	Large (>50%) = 0	Moderate (5-50%) = 2	Small (<5%) = 5	Wetland area: upslope catchment area	Large (>50%) = 0	Moderate (5-50%) = 2	Small (<5%) = 5
Lagg development	None = 0	Minor = 2	Extensive = 5	Lagg development	None expected = 0	Minor Lagg expected = 2	Extensive Lagg expected = 5
Seeps	None = 0	Seasonal = 2	Permanent = 5	Seeps	No additional seeps expected = 0		Additional seeps expected = 5
Surface marl deposits	None = 0		Present = 5				
Iron precipitates	None = 0		Present = 5				

Note:  
- Score to a maximum of 25 points

**2.1.3 Attribute: Groundwater Recharge**

The ability of a wetland to recharge groundwater depends on characteristics of the wetland as well as the surrounding topography and geologic conditions. To provide significant groundwater recharge, a wetland requires a reasonably constant source of water such as a flowing watercourse or surrounding sloping land and the wetland must be located on permeable soils and/or fractured bedrock. Similar to the groundwater discharge function, the measurement of groundwater recharge is complex. However, certain observations can help in understanding and scoring recharge function.

Many cities, towns and private property owners rely on groundwater for domestic use. Without groundwater recharge areas, drinking water quality and quantity would be threatened. Furthermore, groundwater often maintains base flows in watercourses during the dry season, as described in the groundwater discharge section of this report. Therefore, without groundwater recharge, groundwater discharge and subsequently surface water flows are likely to diminish during dry periods. Headwater wetlands (ones located high in drainage basins) have the highest value for groundwater recharge. The EBI utilizes scoring criteria based upon site type and soils. The groundwater recharge EBI weights and scoring criteria for existing and restored conditions are provided in table 2.1.3.

**Table 2.1.3 Weights and Scoring Criteria for Groundwater Recharge**

Existing Condition - Scoring Criteria Maximum Score – 25			Restored Condition - Scoring Criteria Maximum Score - 25		
If wetland is located within a municipal well head protection zone the wetland automatically scores 25. There is no need to calculate scores below.  Wetland Site Type: <ul style="list-style-type: none"> <li>- Zero points for wetlands greater than 50% lacustrine (by area) or located on a major river</li> <li>- Fractional Area of isolated or palustrine wetland X 20 =</li> <li>- Fractional Area of riverine wetland X 8 =</li> <li>- Fraction Area of lacustrine wetland (not dominant site type) x 0 =</li> </ul> Sum the three fractional area's if the site type is less than 50% lacustrine and add this to the Soil Recharge Potential found below:			If wetland is located within a municipal well head protection zone the wetland automatically scores 25. There is no need to calculate scores below.  Wetland Site Type: <ul style="list-style-type: none"> <li>- Zero points for wetlands greater than 50% lacustrine (by area) or located on a major river</li> <li>- Fractional Area of isolated or palustrine wetland X 20 =</li> <li>- Fractional Area of riverine wetland X 8 =</li> <li>- Fraction Area of lacustrine wetland (not dominant site type) x 0 =</li> </ul> Sum the three fractional area's if the site type is less than 50% lacustrine and add this to the Soil Recharge Potential found below:		
Soil Recharge Potential:			Soil Recharge Potential:		
Dominant Wetland Site Type	Sands, gravels, loams	Clays, substrates in high water tables or shallow substrates over	Dominant Wetland Site Type	Sands, gravels, loams	Clays, substrates in high water tables or shallow substrates over

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		impervious materials such as consolidated bedrock			impervious materials such as consolidated bedrock
Lacustrine or major river	0	0		Lacustrine or major river	0
Isolated	5	3		Isolated	3
Palustrine	4	2		Palustrine	2
Riverine	2	1		Riverine	1
Notes:					
- Major Rivers include: St. Clair, Detroit, Niagara, St. Lawrence, Ottawa					
- For the Soil Recharge Potential Table, circle the number that best represents the project site					
- Maximum total score =25 points					

## 2.2 Sub-Component: Water Quality and Carbon Storage

### 2.2.1 Attribute: Short-term Water Quality Improvement in Wetland

Wetlands have been long regarded as valuable landscape features for their water quality improvement value. Wetland soils provide the necessary substrate for vegetation and microorganisms to populate and consume nutrients, metals and other pollutants. Annual plants that produce tremendous amounts of biomass over a short period of time are most efficient at providing short-term water quality improvements. The reason the improvement is short, is because these plants senesce in the autumn, often releasing much of the nutrients they previously removed from the water column.

The water quality improvement value of an individual wetland is dependent upon its location within a catchment, the land use characteristics of the catchment and the type of vegetation present in the wetland. The in wetland short-term water quality improvement EBI weights and scoring criteria for existing and restored conditions are provided in table 2.2.1.

**Table 2.2.1 Weights and Scoring Criteria for Short-term Water Quality Improvement in Wetland**

Existing Condition - Scoring Criteria Maximum Score - 50	Restored Condition - Scoring Criteria Maximum Score - 50
<p>If wetland is located on a major lake (Huron, St. Clair, Erie, Ontario, Simcoe) or major river (St. Clair, Detroit, Niagara, St. Lawrence, Ottawa) the score is 0 and there is no need to calculate the score below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 1.0 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine wetland on lake shoreline x 0.2 =</li> <li>- Fractional area of lacustrine wetland at lake inflow or outflow x 1.0 =</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of the upstream catchment land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.8</li> <li>- Over 50% forested or other natural vegetation = 0.6</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Fractional area of wetland with live trees, shrubs,</li> </ul>	<p>If wetland is located on a major lake (Huron, St. Clair, Erie, Ontario, Simcoe) or major river (St. Clair, Detroit, Niagara, St. Lawrence, Ottawa) the score is 0 and there is no need to calculate the score below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 1.0 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine wetland on lake shoreline x 0.2 =</li> <li>- Fractional area of lacustrine wetland at lake inflow or outflow x 1.0 =</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of the upstream catchment land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.8</li> <li>- Over 50% forested or other natural vegetation = 0.6</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p>

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<p>herbs or mosses x 0.75 =</p> <ul style="list-style-type: none"><li>- Fractional area of wetland with emergent, subemergent or floating vegetation x 1.0 =</li><li>- Fractional area of wetland with little or no vegetation x 0.5 =</li></ul> <p>PUF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 4: Calculation of final score</p> <ul style="list-style-type: none"><li>- 50 x WIF x LUF x PUF</li></ul>	<ul style="list-style-type: none"><li>- Fractional area of wetland with live trees, shrubs, herbs or mosses x 0.75 =</li><li>- Fractional area of wetland with emergent, subemergent or floating vegetation x 1.0 =</li><li>- Fractional area of wetland with little or no vegetation x 0.5 =</li></ul> <p>PUF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 4: Calculation of final score</p> <ul style="list-style-type: none"><li>- 50 x WIF x LUF x PUF</li></ul>
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**2.2.2 Attribute: Short-term Water Quality Improvement in Upland Buffer**

Wetlands have the ability to improve downstream water quality as described in Section 2.2.1. However, the ability of the wetland to improve water quality depends upon the condition of the surrounding upland buffer. For instance, a wetland surrounded by steeply sloping, bare lands with visible signs of erosion gullying will deposit significant amounts of sediment in the wetland, potentially limiting vegetation growth, storage capacity and the water quality improvement function of the wetland. Upland buffer areas that are well vegetated, wide and encourage infiltration remove many water quality contaminants before the water enters the wetland.

The location of the wetland within the catchment area, the land use activities adjacent the wetland buffer, the vegetation composition of the buffer, the soil type and buffer width and steepness all factor into a buffers ability to improve short-term water quality. The short-term water quality improvement in the upland buffer EBI weights and scoring criteria for existing and restored conditions are provided in table 2.2.2.

**Table 2.2.2 Weights and Scoring Criteria for Short-term Water Quality Improvement in Upland Buffer**

<b>Existing Conditions - Scoring Criteria Maximum Score - 50</b>	<b>Restored Conditions - Scoring Criteria Maximum Score - 50</b>
<p>If buffer is greater than or equal to 50m wide, 50 points are scored and there is no need to complete the calculations below. If no buffer currently exists, 0 points are scored and there is no need to complete the calculations below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 0.8 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine on lake shoreline (all but Major Lakes) x 0.5 =</li> <li>- Fractional area of lacustrine on lake shoreline (Major Lakes) x 0.2</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of adjacent land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.6</li> <li>- Over 50% forested or other natural vegetation = 0.4</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p>	<p>If buffer is already or proposed to be greater than or equal to 50m wide, 50 points are scored and there is no need to complete the calculations below. If no buffer is proposed a score of 0 points is awarded and there is no need to complete the calculations below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 0.8 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine on lake shoreline (all but Major Lakes) x 0.5 =</li> <li>- Fractional area of lacustrine on lake shoreline (Major Lakes) x 0.2</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of adjacent land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.6</li> <li>- Over 50% forested or other natural vegetation = 0.4</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Simple species buffer containing only trees, or</li> </ul>

<ul style="list-style-type: none"> <li>- Simple species buffer containing only trees, or shrubs or grasses/forbs = 0.3.</li> <li>- Complex species buffer containing trees, shrubs and grasses/forbs = 1.0.</li> </ul> <p>Step 4: Determination of percent of boundary buffered factor (POBB).</p> <ul style="list-style-type: none"> <li>- 100% of the wetland boundary on the subject property is buffered = 1.0.</li> <li>- 50-99% of the wetland boundary on the subject property is buffered = 0.5.</li> <li>- &lt;50% of the wetland boundary on the subject property is buffered = 0.2</li> </ul> <p>Step 5: Determination of the width factor (WF).</p> <ul style="list-style-type: none"> <li>- 15m to less than 50 m wide = 1.0</li> <li>- 10m to less than 15 m wide = 0.8</li> <li>- 5m to less than 10 m wide = 0.6</li> <li>- Less than 5 m wide = 0.4</li> </ul> <p>Step 6: Determination of steepness factor (SF)</p> <ul style="list-style-type: none"> <li>- Less than 5% = 1.0</li> <li>- 5% to less than 10% = 0.8</li> <li>- 10% to less than 15% = 0.6</li> <li>- Greater than 15% = 0.4</li> </ul> <p>Step 7: Determination of soil texture factor (STF)</p> <ul style="list-style-type: none"> <li>- Sand = 1.0</li> <li>- Loam = 0.7</li> <li>- Clay = 0.4</li> </ul> <p>Step 8: Calculation of final score</p> <ul style="list-style-type: none"> <li>- <math>50 \times WIF \times LUF \times PUF \times POBB \times WF \times SF \times STF</math></li> </ul>	<ul style="list-style-type: none"> <li>shrubs or grasses/forbs = 0.3.</li> <li>- Complex species buffer containing trees, shrubs and grasses/forbs = 1.0.</li> </ul> <p>Step 4: Determination of percent of boundary buffered factor (POBB).</p> <ul style="list-style-type: none"> <li>- 100% of the wetland boundary on the subject property is buffered = 1.0.</li> <li>- 50-99% of the wetland boundary on the subject property is buffered = 0.5.</li> <li>- &lt;50% of the wetland boundary on the subject property is buffered = 0.2</li> </ul> <p>Step 5: Determination of the width factor (WF).</p> <ul style="list-style-type: none"> <li>- 15m to less than 50 m wide = 1.0</li> <li>- 10m to less than 15 m wide = 0.8</li> <li>- 5m to less than 10 m wide = 0.6</li> <li>- Less than 5 m wide = 0.4</li> </ul> <p>Step 6: Determination of steepness factor (SF)</p> <ul style="list-style-type: none"> <li>- Less than 5% = 1.0</li> <li>- 5% to less than 10% = 0.8</li> <li>- 10% to less than 15% = 0.6</li> <li>- Greater than 15% = 0.4</li> </ul> <p>Step 7: Determination of soil texture factor (STF)</p> <ul style="list-style-type: none"> <li>- Sand = 1.0</li> <li>- Loam = 0.7</li> <li>- Clay = 0.4</li> </ul> <p>Step 8: Calculation of final score</p> <ul style="list-style-type: none"> <li>- <math>50 \times WIF \times LUF \times PUF \times POBB \times WF \times SF \times STF</math></li> </ul>
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**2.2.3 Attribute: Long-term Nutrient (Nitrogen/Phosphorus) Trap in Wetland**

Wetlands have the ability to trap nutrients and other chemicals (in the long-term) found in the water which flows through them. Many pollutants found in watercourses are bound to suspended sediments. Water velocities slow when they enter wetlands, allowing for the deposition of some of the sediment and associated pollutants. As this process continues newly settled sediments bury older sediments and no longer can the sediment bound pollutants interact with the water in the wetland and are therefore considered trapped in the long-term.

Generally, the location and physiographic features of the wetland determines how valuable it is a long-term nutrient trap. Wetlands located in a river mouth and/or have permanent open water and subsequently an ample accumulation of organic sediments are considered the most valuable in terms of long-term water quality protection. The long-term nutrient trap in wetland EBI weights and scoring criteria for existing and restored conditions are provided in table 2.2.3.

**Table 2.2.3 Weights and Scoring Criteria for Long-term Nutrient (Nitrogen/Phosphorous) Trap in Wetland**

<b>Existing Condition - Scoring Criteria Maximum Score - 50</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 50</b>
<ul style="list-style-type: none"> <li>- No wetland currently present = zero points</li> <li>- Wetland does not have permanent open water = 10 points</li> <li>- Wetland does have permanent open water = 20 points</li> <li>- Wetland is located in a river mouth = 50 points</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to the existing condition score if the proposed wetland is not located in a river mouth and does not intend to have permanent open water or does not intend to add to the extent of permanent open water</li> <li>- Add 20 points to the existing condition score if the proposed wetland is not located in a river mouth and does intend to add to the extent of the permanent open water.</li> <li>- Wetland will be located in a river mouth = 50 points</li> </ul>

**2.2.4 Attribute: Shoreline Erosion Control**

Shoreline wetlands (i.e. riverine and lacustrine site types) protect shorelines from extreme erosion caused during times of high flow. Generally, wetland vegetation binds the soils under and above the water, reduces current and wave energy by creating friction and increases sediment deposition. The type of vegetation on the shoreline and in the flood plain determines the wetlands ability to reduce shoreline erosion. Well established vegetation with strong root systems is most effective in controlling erosive forces, and consequently provide more protection. Shoreline erosion is to be assessed only for those wetlands that are either lacustrine or riverine in site type. Hence, similar to OWES (2013), a two-step process is proposed for scoring this attribute. Step 1 is the identification of wetland type and Step 2 is the identification of the vegetation type. The shoreline erosion control EBI weights and scoring criteria for existing and restored conditions are provided in table 2.2.4.

**Table 2.2.4 Weights and Scoring Criteria for Shoreline Erosion Control**

<b>Existing Condition - Scoring Criteria Maximum Score - 25</b>	<b>Restored Condition - Scoring Criteria Maximum Score - 25</b>
<p>Step 1:</p> <ul style="list-style-type: none"> <li>- Wetland entirely isolated = zero points</li> <li>- Any part of the wetland palustrine, riverine or lacustrine (proceed to Step 2)</li> </ul> <p>Step 2:</p> <p>Calculate the shoreline vegetation fractional area and multiply by the points indicated below. For diversely vegetated shorelines sum points to a maximum of 25.</p> <ul style="list-style-type: none"> <li>- Fractional area of trees and shrubs x 25 points</li> <li>- Fractional area of emergent vegetation x 12 points</li> <li>- Fractional area of submergent vegetation x 9 points</li> <li>- Fractional area of other shoreline vegetation x 6 points</li> <li>- Fractional area of no vegetation x zero points</li> </ul>	<p>Step 1:</p> <ul style="list-style-type: none"> <li>- Wetland entirely isolated = zero points</li> <li>- Any part of the wetland palustrine, riverine or lacustrine (proceed to Step 2)</li> </ul> <p>Step 2:</p> <p>Calculate the shoreline vegetation fractional area and multiply by the points indicated below. For diversely vegetated shorelines sum points to a maximum of 25.</p> <ul style="list-style-type: none"> <li>- Fractional area of trees and shrubs x 25 points</li> <li>- Fractional area of emergent vegetation x 12 points</li> <li>- Fractional area of submergent vegetation x 9 points</li> <li>- Fractional area of other shoreline vegetation x 6 points</li> <li>- Fractional area of no vegetation x zero points</li> </ul>

**2.2.5 Attribute: Carbon Storage**

The long-term storage of carbon occurs within wetlands that are actively accumulating organic sediments under saturated conditions. These sediments are accumulated through the growth and death of wetland vegetation and through the settling of suspended sediments within the wetland. Keeping carbon stored in the long-term is dependent on water levels in the wetland. If water levels drop and the organic soils are exposed to oxygen, mineralization of the carbon quickly occurs and as result, atmospheric carbon dioxide is produced. Because the long-term storage of carbon is dependent on saturated conditions, this attribute is evaluated within the hydrological component. The carbon storage EBI weights and scoring criteria for existing and restored conditions are provided in table 2.2.5.

**Table 2.2.5 Weights and Scoring Criteria for Carbon Storage**

Existing Condition - Scoring Criteria Maximum Score - 15	Restored Condition - Scoring Criteria Maximum Score - 25
<ul style="list-style-type: none"> <li>- Wetland does not have permanent open water = 5 points</li> <li>- Wetland does have permanent open water = 15 points</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to the existing condition score if the proposed wetland does not intend to have permanent open water or does not intend to add to the extent of the existing permanent open water</li> <li>- Add 10 points to the existing condition score if the proposed wetland does intend to add to the extent of the permanent open water</li> </ul>

### **3.0 Component: Social**

The social component of the EBI measures the value of the goods, recreation, aesthetics, education/research and cultural and aboriginal benefits provided by wetlands. It is important to note that the EBI is only intended to measure public benefits provided by the wetland and it is not intended to value the benefits experienced directly by the landowner who is undertaking the wetland restoration project. For example, if a property owner cuts firewood from the wetland for personal use, this is not considered a public benefit. However, if firewood is cut from the wetland and it is sold to the public, this would be considered a public benefit and therefore eligible to receive points.

The social component differs from the biological and hydrological component when attempting to assess the value of the wetlands existing condition. For the biological and hydrological components, this exercise is practical because characteristics of the landscape provide the necessary information to measure the existing condition. Measuring the existing condition for many of the social component attributes is more challenging because it is not the measurement of biophysical properties. Instead, statements from the wetland manager would have to be used. Given that it is impossible to confirm these statements as accurate, it was decided by the Steering Committee to assign an automatic score of zero to the existing conditions for all attributes within the social component and only measure the restored condition. The one exception to this is the landscape aesthetics attribute. This attribute is evaluated for both the existing and restored condition.

This component is comprised of five sub-components each with one attribute. Within this section, each attribute of the social component is described in detail.

#### **3.1 Sub-Component: Goods**

##### ***3.1.1 Attribute: Sustainable Use of the Wetland for Harvesting Goods***

Wetlands provide a variety of ecosystem goods such as fuelwood, fibre, meat/fish and timber. Without practicing responsible resource management and harvesting best practices, the wetlands' ability to supply these goods in the long-term is threatened. Therefore, the wetland restoration EBI only recognizes sustainable harvesting of goods as a public benefit. The sustainable use of the wetland for harvesting goods EBI weights and scoring criteria for the restored condition are provided in table 3.1.1.

**Table 3.1.1 Weights and Scoring Criteria for the Sustainable Use of the Wetland for Harvesting Goods**

Existing Condition - Scoring Criteria Automatic Score – zero	Restored Condition - Scoring Criteria Maximum Score - 25
<ul style="list-style-type: none"> <li>- Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>- Zero points for no harvesting of food, fuel and/or fibre or allow harvesting without ensuring best management practices are followed (i.e. do not have a Managed Forest Plan, do not use licensed hunters, anglers or trappers)</li> <li>- 25 points for allowing the harvesting of food, fuel and/or fibre and ensure that best management practices are followed (i.e. fuel and fibre wood harvested in accordance with a Managed Forest Plan and licensed hunters, anglers and trappers utilized to harvest pelts)</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- If the timber associated with the wetland is immature at the moment and the Managed Forest Plan does not call for a thinning within the next 10 years award 25 points if the landowner intends to allow timber harvesting in subsequent Managed Forest Plan updates.</li> <li>- If fish are harvested, points are to be scored here and not within the Recreation Sub-Component</li> <li>- Due to the devastating impacts to wetland quality, peat extraction is not recognized as a public good scored in this tool</li> </ul>	

### 3.2 Sub-Component: Recreation

#### 3.2.1 Attribute: Sustainable Use of the Wetland for Recreation

Wetlands may be used for a variety of recreational activities including: catch and release fishing, hiking, bird watching and nature enjoyment.

Currently, many researchers are working in the area of “EcoHealth” to better define the correlation between outdoor recreation and personal health and well-being, and although much work is to be completed in this field, it is agreed that there are positive public benefits associated with natural space recreation. Hence, sustainable use of wetlands for recreational activities is included as part of the EBI. EBI weights and scoring criteria for the restored condition are provided in table 3.2.1.

**Table 3.2.1 Weights and Scoring Criteria for Recreational Activities**

Existing Condition - Scoring Criteria Automatic Score – zero	Restored Condition - Scoring Criteria Maximum Score - 25
<ul style="list-style-type: none"> <li>- Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>- Zero points for no public allowance</li> <li>- 10 points for public allowance on an infrequent situation by situation (daily) basis</li> <li>- 20 points for public allowance on a more frequent (long-standing) informal basis</li> <li>- 25 points for year round formalized access (i.e. Bruce Trail crosses the property)</li> </ul>
<p>Notes:</p> <ul style="list-style-type: none"> <li>- Example recreation activities eligible for points include: catch and release fishing, hiking, bird watching and nature enjoyment</li> <li>- If angling is catch and release only, points are to be scored here and not within the Goods Sub-Component</li> </ul>	

### 3.3 Sub-Component: Aesthetics

#### 3.3.1 Attribute: Landscape Aesthetics

The rural countryside and its forests, farm fields, rivers, meadows and wetlands provide a variety of beautiful sights, valued by photographers, painters, residents and tourists. Natural spaces, including wetlands, have the ability to bring joy into the lives of those who are able to view them. Aesthetic appreciation of a wetland often relates to the qualities of openness, diversity and uniqueness. Not only does the wetland have to be within visible range of the public, it must also be distinct from its surroundings in order to be valued for its aesthetic quality. The landscape aesthetics EBI weights and scoring criteria for the existing and restored condition are provided in table 3.3.1.

**Table 3.3.1 Weights and Scoring Criteria for Landscape Aesthetics**

Existing Condition - Scoring Criteria Maximum Score – 25	Restored Conditions – Scoring Criteria Maximum Score - 25
<ul style="list-style-type: none"> <li>- Zero points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is not distinctly recognizable on the landscape</li> <li>- 10 points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is distinctly recognizable on the landscape</li> <li>- 20 points for wetland less than 120m from a public road/trail/navigable waterway or neighbouring property</li> <li>- 25 points for wetland that is immediately adjacent a public road/trail/navigable waterway or neighbouring property</li> </ul>	<ul style="list-style-type: none"> <li>- Zero points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is not distinctly recognizable on the landscape</li> <li>- 10 points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is distinctly recognizable on the landscape</li> <li>- 20 points for wetland less than 120m from a public road/trail/navigable waterway or neighbouring property</li> <li>- 25 points for wetland that is immediately adjacent a public road/trail/navigable waterway or neighbouring property</li> </ul>

**3.4 Sub-Component: Education and Research**

**3.4.1 Attribute: Use of the Wetland for Education and/or Research Activities**

Wetlands may be used by school groups for educational exercises and/or observations or by researchers to advance our knowledge of the natural and human sciences. Wetland-owners that provide access to their lands for educational and research purposes are providing a public benefit. The use of the wetland for education and Research activities EBI weights and scoring criteria for the restored condition are provided in table 3.4.1.

**Table 3.4.1 Weights and Scoring Criteria for Education and Research Activities**

<b>Existing Condition - Scoring Criteria Automatic Score – zero</b>	<b>Restored Conditions - Scoring Criteria Maximum Score - 25</b>
- Not applicable	<ul style="list-style-type: none"> <li>- Zero points for no public allowance</li> <li>- 10 points for minimal public allowance on an infrequent situation by situation (daily) basis</li> <li>- 20 points for public allowance on a more frequent (ongoing) basis</li> <li>- 25 points for public allowance on a more frequent (ongoing) basis and landowner is willing to participate in education and research activities</li> </ul>

### 3.5 Sub-Component: Cultural and Aboriginal values

#### 3.5.1 Attribute: Enhancement to the Historical, Religious and/or Spiritual Values of the Wetland

Many wetlands have cultural significance. Cultural values may stem from a noteworthy historic event that transpired in or at the edge of a wetland or because there is evidence of physical change brought about by humans. These values may include archaeological sites, historic trails or portages, log chutes, burial sites, and historic fishing ports (OWES, 2013). Wetland restoration projects that include enhancement to the historical, religious, and/or spiritual values of the wetland are eligible activities to score points. The EBI weights and scoring criteria for the restored condition of this attribute are provided in table 3.5.1.

**Table 3.5.1 Weights and Scoring Criteria for Historical, Religious, and Spiritual Values**

Existing Condition - Scoring Criteria Automatic Score – zero	Restored Condition - Scoring Criteria Maximum Score - 25
- Not applicable	<ul style="list-style-type: none"> <li>- Zero points for no enhancements to the historical, national, religious or spiritual value of the wetland</li> <li>- 25 points for a documented enhancement to the historical, national, religious or spiritual value of the wetland</li> </ul>
Notes: <ul style="list-style-type: none"> <li>- Applicants are encouraged to contact local First Nations and historical societies to determine site significance</li> <li>- Example activities eligible for points include: interpretive signage (e.g. sign informing visitors of a historic trade route through the wetland or preservation of a historical dam), public use of the wetland for religious ceremonies, or presence of sacred sites or use of the wetland for song, chant and/or stories</li> </ul>	

### **3.3 WEIGHTING OF ATTRIBUTES**

As previously stated, the maximum score for each attribute suggests the importance of that attribute relative to other attributes in the EBI. For instance, flood attenuation has a maximum score of 75 points, whereas groundwater discharge has a maximum score of 25 points. Therefore, the EBI weights the value of wetlands for flood attenuation services three times higher than that of groundwater discharge services. The maximum score for each attribute, and therefore weight can be reviewed and if necessary modified by the conservation practitioner to meet local conditions and priorities.

The total maximum points awarded in the EBI are 544 and 733 for the existing and restored conditions, respectively. To calculate the final EBI score, two values are considered; the existing conditions total score and change in condition total score (i.e. restored condition score minus existing condition score).

The Steering Committee conducted a sensitivity analysis utilizing a variety of different weighting proportions for the existing and the change in conditions scores and determined that a weighing of 0.55 for the existing condition and 0.45 for the change in condition produced the most desirable EBI results. Proposed projects that would result in significant wetland restoration improvements to sites of already fair quality would score best and conversely projects proposing poor restoration projects, regardless of the existing wetland state would score poorly. Similar to the attribute scores, conservation practitioners must review the existing condition and the change in condition weights and adjust them to meet local conditions and priorities when necessary.

To calculate the final EBI score the weighted existing conditions score and the weighted change in conditions scores are summed. To observe how the existing and change in condition scores are weighted and how the final EBI score is calculated, refer to the Wetland Restoration EBI Calculator found here: <http://www.creditvalleyca.ca/watershed-science/our-watershed/ecological-goods-services/>

### **3.4 CLIMATE MITIGATION AND POLLUTION REDUCTION SCORES**

Climate change is regarded as the most significant ecological stressor facing the planet. A rapidly changing climate disrupts physical processes which in turn affect all biological processes. All species of flora and fauna are likely to struggle with adapting to the changing climate and it is possible that many may not succeed. The restoration of wetlands assists with the mitigation of and adaptation to climate change by sequestering and storing carbon, reducing the likelihood of floods, maintaining base flows in watercourses and ensuring aquifers are supplied with groundwater. Because climate change mitigation and adaptation is of extreme significance, the EBI includes a climate mitigation score. The maximum possible score for climate mitigation is 175 and this is simply the sum of the change in condition scores for the carbon sequestration, flood attenuation, groundwater discharge, groundwater recharge and carbon storage attributes.

Similar to climate change, pollution of our air and water is a widespread issue of concern. Intensive land use activities such as urbanization, agricultural production, golf course operations and aggregate extraction alter the natural processes that connect land, water and air and as a result, air and water quality is often impaired. The restoration of wetlands improves air and water quality by reducing, capturing and/or treating many contaminants of concern. To account for this, the EBI includes a pollution reduction score. The maximum possible score is 225 and is simply the sum of the change in condition scores for the carbon sequestration, short-term water quality improvement in the wetland and in the buffer, long-term nutrient trap, shoreline erosion control protection and carbon storage.

These two scores cannot be utilized as the primary scores to evaluate the value of a proposed wetland restoration project. Doing so would neglect the value provided by the other biological, hydrological and social attributes not accounted for in these scores. Hence, it is recommended that the climate change and/or pollution reduction scores be utilized for information purposes or potentially as a tie-breaking measure when two proposed wetland restoration projects happen to achieve the same total EBI score.

#### **4.0 ENVIRONMENTAL BENEFIT INDEX CALCULATOR**

The Wetland Restoration EBI Calculator was developed to facilitate the computation of the final EBI score and climate mitigation and pollution reduction scores. As previously mentioned, conservation practitioners may wish to alter the maximum scores and weights so that the EBI is appropriate for their geographic location and/or to meet local priorities. Because of this necessary program flexibility, Microsoft Excel was used as the platform for developing the EBI Calculator Tool. An additional benefit of using Microsoft Excel is that it is a widely available program and many conservation practitioners are familiar with using the program.

The EBI and associated Calculator Tool allows conservation practitioners that are engaged in wetland restoration incentive programming to make two determinations: i) which projects to fund based on the biological, hydrological and social benefits provided by the restored wetland, and; ii) which projects to fund based on the cost-to-benefit ratio of each proposed project. The EBI can be adapted for use within a variety of incentive program designs. Conservation practitioners are encouraged to investigate multiple incentive program designs before committing to a specific design. In addition, care should be taken when considering how to use the EBI as the benefits evaluation tool and funding decision tool within the chosen incentive program design.

Follow the steps below to begin using the Wetland Restoration EBI Calculator:

##### **Determination of Quality Wetland Restoration Projects**

1. Save the WetlandRestorationEBICalculator.xlsx file from the CVC Ecosystem Goods and Services website (<http://www.creditvalleyca.ca/watershed-science/our-watershed/ecological-goods-services/>) to your computer.
2. Open the Wetland Restoration EBI Calculator file from your computer and save the file as: *Project Name\_Wetland\_Restoration\_EBI\_Calculator.xlsx*. It is best to use a unique identifier for the project name such as the property address so as to avoid multiple files with the same name.
3. Repeat step 2 as many times as necessary to create a file for each proposed wetland restoration project.

4. Review the maximum points for the existing (Column D) and restored (Column F) conditions for each attribute to ensure that they appropriately reflect your geographic location and/or local priorities. Remember that the higher the maximum score, the more that attribute is valued as a public good/service. If changes are made to the maximum scores, in the calculator tool remember that the scoring criteria must also be changed.
5. Review the weighting assigned to the existing condition and change in condition in Row 48 to ensure that they appropriately reflect your geographic location and/or local priorities. Remember, increasing the weighting number of change in condition and reducing the weighting number of existing condition favours restoration projects that bring about significant environmental improvements regardless of the project sites initial quality. Increasing the weighting number of existing condition and reducing the weighting of change in condition favours restoration projects that are proposed for already fair quality sites. **Caution should be used when deviating far from a weighting of 0.55 for existing conditions and 0.45 for change in conditions. Also remember that the sum of weighting for existing conditions and change in conditions should always be equal to 1.00.**
6. Utilizing the scoring criteria presented in Section 3 of this report, score each attribute for the existing and proposed restored condition of the project site.
7. Once complete, save the file for future reference.
8. To compare multiple projects create a new EXCEL file called: Final\_Scores\_Wetland\_Restoration\_EBI.xlsx and save it to your computer.
9. Within the newly created file create a table that summarizes the EBI Scores, Climate Mitigation Scores and Pollution Reduction Scores for all evaluated projects. Sort this data from highest to lowest final EBI scores to achieve a ranking of the most beneficial to the least beneficial projects.
10. If two or more projects have the same EBI scores, use Climate Mitigation and/or Pollution Reduction scores to rank those projects.

## **5.0 CONCLUSIONS**

Wetlands are the most valuable ecosystem. Despite this, wetlands continue to be lost or negatively impacted by urbanization, agriculture, golf courses and aggregate sites. Within the Greenbelt, most wetlands, and land where wetlands once existed, are privately owned, therefore public institutions are unable to rectify this problem without cooperation from private landowners. CVC has a long history of working with rural landowners to restore natural features and functions on their lands, however, wetland restoration has always been challenging due to high costs and an undervaluing of the benefits they provide.

In this study, an Environmental Benefit Index (EBI) specific to wetlands that is suitable for use within the Greenbelt landscape was developed. In addition, a Microsoft Excel based Wetland Restoration EBI Calculator was created to aid in the EBI calculations. Completion of this EBI allows for the administration of a wetland restoration reverse auction program. In such a program, the EBI would be used as the tool to measure the benefits associated with undertaking the proposed wetland restoration projects. The benefits would be assessed against the cost of each proposed project to determine the most cost-beneficial projects to implement.

## 6.0 REFERENCES

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7.0 APPENDICES

APPENDIX 1: ENVIRONMENTAL BENEFIT INDEX

Component	Sub-Component	Attribute	Max Score (existing/restored)	Scoring Criteria Existing Condition	Scoring Criteria Restored Condition
1.0 Biological	1.1 Wetland Site Characteristics and Biodiversity	1.1.1 Wetland type (Bog, fen, swamp, and marsh)	10/10	<ul style="list-style-type: none"> <li>- Zero points for no existing wetland</li> <li>- Fractional Area x 5 points for marsh</li> <li>- Fractional Area x 8 points for swamp</li> <li>- Fractional Area x 10 points for bog and/or fen</li> </ul> <p>Notes:</p> <ul style="list-style-type: none"> <li>- The Fractional Area (FA) of all wetlands must equal 1, regardless of whether or not there are multiple wetland types present. For example, a wetland that only contains marsh would have a score of 5 points (FA(1) x 5 = 5 points), however, a wetland that contains 50% swamp and 50% bog would have a score of 9 points (FA(0.5) x 8 = 4 points swamp and FA(0.5) x 10 = 5 points bog, totaling 9 points)</li> <li>- Scores must be recorded as whole numbers. If necessary, use standard rounding rules to calculate final score (i.e. 7.5 is recorded as 8 and 7.4 is recorded as 7)</li> </ul>	<ul style="list-style-type: none"> <li>- Fractional Area x 5 points for marsh</li> <li>- Fractional Area x 8 points for swamp</li> <li>- Fractional Area x 10 points for bog and/or fen</li> </ul>
		1.1.2 Effective project area (i.e. the area of wetland created or enhanced as a result of the restoration project).	0/20	<ul style="list-style-type: none"> <li>- Not applicable</li> </ul> <p>Note:</p> <ul style="list-style-type: none"> <li>- The wetland area is measured from the high water mark or to the point where there is less than 50% wetland vegetation, whichever is greater</li> </ul>	<ul style="list-style-type: none"> <li>- 2 points for less than 0.5 hectare</li> <li>- 5 points for greater than or equal to 0.5 hectare but less than 2 hectares</li> <li>- 10 points for greater than or equal to 2 hectares but less than 5 hectares</li> <li>- 15 points for greater than or equal to 5 hectares but less than 10 hectares</li> <li>- 20 points for greater than or equal to 10 hectares</li> </ul>
		1.1.3 Proximity to other wetlands	10/10	<ul style="list-style-type: none"> <li>- 4 points for no wetland within 120m of the restoration project</li> <li>- 6 points for a wetland that exists within 30-120 m of the restoration project</li> <li>- 8 points for a wetland that exists within 10 – 29 m of the restoration project</li> <li>- 10 points for a wetland that exists less than 10 m from the wetland restoration project</li> </ul>	<ul style="list-style-type: none"> <li>- 4 points for no wetland within 120m of the restoration project</li> <li>- 6 points for a wetland that exists within 30-120 m of the restoration project</li> <li>- 8 points for a wetland that exists within 10 – 29 m of the restoration project</li> <li>- 10 points for a wetland that exists less than 10 m from the wetland restoration project</li> </ul>
		1.1.4 Permanent and seasonal open water types	10/10	<ul style="list-style-type: none"> <li>- Zero points for no permanent or seasonal open water</li> <li>- 2 points for more than 95% of the area as permanent open water</li> <li>- 4 points for less than 5% of the area as permanent open water and /or less than 5% of the area as seasonal open water</li> <li>- 4 points for 5-25% of area as permanent open water and it is occurring in the central portion of wetland</li> <li>- 4 points for 76-95% of area as permanent open water, occurring in large central area; vegetation is peripheral</li> <li>- 6 points for 5-25% of area as permanent open water, occurring in various sized ponds; vegetation in dense patches or diffuse open stands</li> <li>- 6 points for 76-95% of area as permanent open water; vegetation occurs in patches or diffuse open stands</li> <li>- 8 points for 26-75% of area as permanent open water, occurring in central portion of wetland</li> <li>- 10 points for 26-75% of area as permanent open water, occurring in pattern of small ponds; embayments are common and/or 6-100% of area as seasonal open water</li> </ul> <p>Notes:</p>	<ul style="list-style-type: none"> <li>- Zero points for no permanent or seasonal open water</li> <li>- 2 points for more than 95% of the area as permanent open water</li> <li>- 4 points for less than 5% of the area as permanent open water and /or less than 5% of the area as seasonal open water</li> <li>- 4 points for 5-25% of area as permanent open water and it is occurring in the central portion of wetland</li> <li>- 4 points for 76-95% of area as permanent open water, occurring in large central area; vegetation is peripheral</li> <li>- 6 points for 5-25% of area as permanent open water, occurring in various sized ponds; vegetation in dense patches or diffuse open stands</li> <li>- 6 points for 76-95% of area as permanent open water; vegetation occurs in patches or diffuse open stands</li> <li>- 8 points for 26-75% of area as permanent open water, occurring in central portion of wetland</li> <li>- 10 points for 26-75% of area as permanent open water, occurring in pattern of small ponds; embayments are common and/or 6-100% of area as seasonal open water</li> </ul>

			<ul style="list-style-type: none"> <li>- Includes the presence of streams and rivers within the wetland limits</li> <li>- Permanent open water is year round standing water with or without emergent vegetation</li> <li>- Seasonal open water includes intermittent watercourses and vernal pools that contain ponded water for greater than 2 months of the year.</li> <li>- When assessing open water do not include areas with vegetation so dense that a duck could not swim through it</li> </ul>				
		1.1.5 Interspersion	10/10	<ul style="list-style-type: none"> <li>- 2 point for less than 20 intersections</li> <li>- 4 points for 21-30 intersections</li> <li>- 6 points for 31-40 intersections</li> <li>- 8 points for 41-50 intersections</li> <li>- 10 points for greater than 50 intersections</li> </ul>		<ul style="list-style-type: none"> <li>- 2 point for less than 20 intersections</li> <li>- 4 points for 21-30 intersections</li> <li>- 6 points for 31-40 intersections</li> <li>- 8 points for 41-50 intersections</li> <li>10 points for greater than 50 intersections</li> </ul>	
		1.1.6 Vegetation communities on the site	45/45	# of communities with 1-3 forms 1 = 1.5 points 2 = 2.5 points 3 = 3.5 points 4 = 4.5 points 5 = 5 points 6 = 5.5 points 7 = 6 points 8 = 6.5 points 9 = 7 points 10 = 7.5 points 11 = 8 points + 0.5 for each additional community	# of communities with 4-5 forms 1 = 2 points 2 = 3.5 points 3 = 5 points 4 = 6.5 points 5 = 7.5 points 6 = 8.5 points 7 = 9.5 points 8 = 10.5 points 9 = 11.5 points 10 = 12.5 points 11 = 13 points + 0.5 for each additional community	# of communities with 1-3 forms 1 = 1.5 points 2 = 2.5 points 3 = 3.5 points 4 = 4.5 points 5 = 5 points 6 = 5.5 points 7 = 6 points 8 = 6.5 points 9 = 7 points 10 = 7.5 points 11 = 8 points + 0.5 for each additional community	# of communities with 4-5 forms 1 = 2 points 2 = 3.5 points 3 = 5 points 4 = 6.5 points 5 = 7.5 points 6 = 8.5 points 7 = 9.5 points 8 = 10.5 points 9 = 11.5 points 10 = 12.5 points 11 = 13 points + 0.5 for each additional community
				Note: - Sum all community scores together to calculate the final score. For example, a wetland with 3 x one form communities, 4 x two form communities and 2 x five form community would score 10 points (i.e. 7 x 1-3 forms = 6 points + 2 x 4-5 forms = 3.5 points = 9.5 points which would round-up to 10 points)			
		1.1.7 Diversity of surrounding habitat (within 120m of restored wetland boundaries)	10/10	(check all appropriate items)  For each surrounding habitat type assign 1 point to a maximum of 10 points  _ non-intensive agriculture (hay/pasture) _ abandoned agricultural land _ deciduous forest _ coniferous forest _ mixed forest* _ abandoned pits and quarries _ open lake or deep river _ terrain appreciably undulating, hilly or with ravines _ creek flood plain _ grassland		(check all appropriate items)  For each surrounding habitat type assign 1 point to a maximum of 10 points  _ non-intensive agriculture (hay/pasture) _ abandoned agricultural land _ deciduous forest _ coniferous forest _ mixed forest* _ abandoned pits and quarries _ open lake or deep river _ terrain appreciably undulating, hilly or with ravines _ creek flood plain _ grassland	
				Notes: - Assess this attribute for the area within 120m of the restored wetland boundary - Mixed forest defined as either 25% coniferous trees distributed singularly or in clumps in deciduous forest, or 25% deciduous trees distributed singly or in clumps in coniferous forest			
		1.1.8 Carbon Sequestration	15/25	<ul style="list-style-type: none"> <li>- 5 points for aquatic dominated vegetation</li> <li>- 10 points for grass/forb dominated vegetation</li> <li>- 15 points tree dominated vegetation</li> </ul>		<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if no plantings are planned as part of the proposed wetland project.</li> <li>- Add 5 points to existing condition score if aquatic vegetation will be planted</li> </ul>	

					<ul style="list-style-type: none"> <li>- Add 8 points to existing condition score if grass/forbs will be planted</li> <li>- Add 10 points to existing condition score if trees will be planted</li> </ul>
				<p>Notes:</p> <ul style="list-style-type: none"> <li>- For the existing condition, choose the option that best represents the project location (i.e. wetland and natural buffer area)</li> <li>- For the restored condition, add points until a maximum of 25 is reached</li> </ul>	
	<b>Subtotal</b>		<b>110/140</b>		
1.2 Wildlife and Wildlife Habitat	1.2.1 Reproductive habitat for endangered and/or threatened species	12/24	<ul style="list-style-type: none"> <li>- zero points for no record of endangered or threatened species reproducing in the existing wetland or no wetland currently exists</li> <li>- 6 points for confirmed reproductive use of the existing wetland by one endangered and/or threatened species</li> <li>- 12 points for confirmed reproductive use of the existing wetland by more than one endangered and/or threatened species</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if there is no predicted reproductive benefit to endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 6 points to existing condition score if there is a predicted reproductive benefit to one endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 12 points to existing condition score if there is a predicted reproductive benefit to more than one endangered or threatened species as a result of the wetland restoration project</li> </ul>	
			<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of species at risk</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Species at risk recovery strategies are to be used to validate likelihood that the proposed project will have a reproductive benefit to species at risk</li> </ul>		
	1.2.2 Traditional migration, feeding or hibernation habitat for endangered and/or threatened species	12/24	<ul style="list-style-type: none"> <li>- zero points for no record of endangered or threatened species utilizing the existing wetland for migration, feeding or hibernating in the existing wetland or no wetland currently exists</li> <li>- 6 points for confirmed use of the existing wetland for migration, feeding and hibernating by one endangered and/or threatened species</li> <li>- 12 points for confirmed use of the existing wetland for migration, feeding and hibernating by more than one endangered and/or threatened species</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if there is no predicted migration, feeding and hibernating benefit to endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 6 points to existing condition score if there is a predicted migration, feeding and/or hibernating benefit to one endangered or threatened species as a result of the wetland restoration project</li> <li>- Add 12 points to existing condition score if there is a predicted migration, feeding and/or hibernating benefit to more than one endangered or threatened species as a result of the wetland restoration project</li> </ul>	
			<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of species at risk</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Species at risk recovery strategies are to be used to validate the likelihood that the proposed project will have a migration, feeding and/or hibernation benefit to species at risk</li> </ul>		
	1.2.3 Presence of locally, regionally, and/or provincially significant plant and animal species that directly benefit from the existence of wetlands.	20/30	<ul style="list-style-type: none"> <li>- zero points for no locally, regionally, and/or provincially significant plant or animal species within 120m of the effective project area</li> <li>- 10 points for one locally, regionally, and/or provincially significant plant or animal species within 120 m of the effective project area</li> <li>- 20 points for more than one locally, regionally, and/or provincially significant plant and/or animal species within 120 m of the effective project area</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score if the project is not anticipated to benefit a locally, regionally and/or provincially significant plant or animal species</li> <li>- Add 5 points to existing condition score if the project is anticipated to benefit one locally, regionally and/or provincially significant plant or animal species</li> <li>- Add 10 points to existing condition score if the project is anticipated to benefit more than one locally, regionally, and/or provincially significant plant or animal species</li> </ul>	
			<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate presence/absence of significant species</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Where available, species at risk strategies or other documents are to be used to validate the likelihood that the proposed project will have a benefit to any locally, regionally, and/or provincially significant species</li> </ul>		
	1.2.4 Nesting and feeding habitat for colonial	10/15	<ul style="list-style-type: none"> <li>- Zero points for not known or not possible (i.e. no open water) to have fed or nested</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no improved benefit to nesting and feeding habitat for colonial waterbirds as a result of the</li> </ul>	

		waterbirds		<ul style="list-style-type: none"> <li>- 4 points for active feeding area (except great blue heron)</li> <li>- 7 points for known to have nested within the past 5 years</li> <li>- 10 points for currently nesting colony</li> </ul>	<ul style="list-style-type: none"> <li>- wetland restoration project</li> <li>- Add 5 points to existing condition score for improvement to the nesting and/or feeding habitat for colonial waterbirds as a result of the wetland restoration project</li> </ul>
				<p>Notes:</p> <ul style="list-style-type: none"> <li>- Only the following wetland dependent colonial waterbirds are eligible to be scored: red-necked grebe, black-crowned night heron, great egret, black tern, caspian tern, common tern and great blue heron (scored for nesting only)</li> <li>- Local records to be used to validate feeding/nesting of colonial waterbirds</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Where available, documents are to be used to validate the likelihood that the proposed project will have a benefit to colonial waterbirds</li> </ul>	
		1.2.5 Waterfowl breeding, staging and/or moulting area	10/15	<ul style="list-style-type: none"> <li>- Zero points for no evidence of waterfowl breeding, staging and/or moulting or no wetland currently exists</li> <li>- 2 points for evidence of waterfowl breeding, staging and/or moulting at any scale</li> <li>- 4 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered locally significant</li> <li>- 7 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered watershed significant</li> <li>- 10 points for evidence of waterfowl breeding, staging and/or moulting to a scale that would be considered provincially significant</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no increase in wetland area</li> <li>- Add 2 points to existing condition score for an increase in wetland area of up to 0.5 hectares</li> <li>- Add 3 points to existing condition score for an increase in wetland area of more than 0.5 hectares but less than 2 hectares</li> <li>- Add 5 points to existing condition score for an increase in wetland area greater than or equal to 2 hectares</li> </ul>
				<p>Notes:</p> <ul style="list-style-type: none"> <li>- Local records to be used to validate significance of waterfowl breeding, staging and/or moulting area</li> <li>- Record must be no more than 20 years old to be considered valid</li> <li>- Geese are not considered an eligible species of waterfowl to score. Wetland restoration designs intended to benefit geese are not encouraged.</li> </ul>	
		1.2.6 Migratory passerine, shorebird, or raptor stopover area.	10/15	<ul style="list-style-type: none"> <li>- Zero points for no evidence of existing wetland being used for stopover habitat by migratory passerine, shorebird, or raptors or no wetland currently exists</li> <li>- 2 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat at any scale</li> <li>- 4 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered locally significant</li> <li>- 7 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered watershed significant</li> <li>- 10 points for evidence of migratory passerine, shorebird or raptors utilizing the existing wetland for stopover habitat to a scale that would be considered provincially significant</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to existing condition score for no increase in wetland area</li> <li>- Add 2 points to existing condition score for an increase in wetland area of up to 0.5 hectares</li> <li>- Add 3 points to existing condition score for an increase in wetland area of more than 0.5 hectares but less than 2 hectares</li> <li>- Add 5 points to existing condition score for an increase in wetland area greater than or equal to 2 hectares</li> </ul>
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		1.2.7 Fish Habitat	20/20	<ul style="list-style-type: none"> <li>- Zero points for no existing fish habitat</li> <li>- Fractional Area of wetland feature x 3 points for seasonal habitat without piscivores</li> <li>- Fractional Area of wetland feature x 8 points for seasonal habitat with piscivores</li> <li>- Fractional Area of wetland feature x 15 points for permanent habitat without piscivores</li> <li>- Fractional Area of wetland feature x 20 points for permanent habitat with piscivores</li> </ul>	<ul style="list-style-type: none"> <li>- Fractional Area of wetland feature x 3 point for seasonal habitat predicted to not have piscivores</li> <li>- Fractional Area of wetland feature x 8 points for seasonal habitat predicted to have piscivores</li> <li>- Fractional Area of wetland feature x 15 points for permanent habitat predicted to not have piscivores</li> <li>- Fractional Area of wetland feature x 20 points for permanent habitat predicted to have piscivores</li> </ul>

				Notes: - The Fractional Area (FA) of all wetlands must equal 1, regardless of whether or not there are multiple wetland types present - Scores must be recorded as whole numbers. If necessary, use standard rounding rules to calculate the final score (i.e. 7.5 is recorded as 8 and 7.4 is recorded as 7). - When calculating FA only include the area up to the high water mark - Record must be no more than 20 years old to be considered valid - <i>Piscivores</i> : fish that eat other fish - Fish stocking is not regarded as a wetland restoration activity																									
	<b>Subtotal</b>		<b>94/143</b>																										
	<b>TOTAL</b>		<b>204/283</b>																										
<b>2.0 Hydrological</b>	2.1 Flood Attenuation and Ground Water Recharge/Discharge	2.1.1 Flood attenuation capacity	75/75	<p>Step #1: Determine flood volume generated by upstream catchment area under a 5, 10, 25, 50 and 100 year design storm –return period.</p> <p>Volume= Area (ha) x Runoff Coefficient (dimensionless) x Rainfall Amount (mm)</p> <p>Where:</p> <ul style="list-style-type: none"> <li>- Area = catchment area upstream of proposed project site. Note: the use of GIS mapping programs facilitate this process.</li> <li>- Runoff Coefficient= 0-1 rating depending on extent of imperviousness of upstream catchment area. See Appendix 2 for a table and description on how to calculate this value.</li> <li>- Rainfall Amount= a fixed amount of rainfall expected for specific design storm events. These rainfall amounts are determined utilizing the Ministry of Transportation of Ontario (MTO) online tool found here: <a href="http://www.mto.gov.on.ca/IDF_Curves/terms.shtml">http://www.mto.gov.on.ca/IDF_Curves/terms.shtml</a> Note: copy the rainfall amount values found in Row A of the MTO online tool and place them under the corresponding design storm – return period in the table below:</li> </ul> <table border="1"> <thead> <tr> <th>Design Storm – Return Period</th> <th>5 year</th> <th>10 year</th> <th>25 year</th> <th>50 year</th> <th>100 year</th> </tr> </thead> <tbody> <tr> <td>Rainfall Amount</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Step #2: Calculate the maximum available flood volume storage of the existing wetland (if one exists).</p> <p>Volume = <math>(a_1+a_2/2) \times H</math></p> <p>Where:            Volume= total potential wetland flood water storage            a<sub>1</sub>= area of wetland base            a<sub>2</sub>= area of wetland high water mark            H = depth of water when at high water boundary of wetland</p>	Design Storm – Return Period	5 year	10 year	25 year	50 year	100 year	Rainfall Amount						<p>Step #1: Determine flood volume generated by upstream catchment area under a 5, 10, 25, 50 and 100 year design storm –return period.</p> <p>Volume= Area (ha) x Runoff Coefficient (dimensionless) x Rainfall Amount (mm)</p> <p>Where:</p> <ul style="list-style-type: none"> <li>- Area = catchment area upstream of proposed project site. Note: the use of GIS mapping programs facilitate this process.</li> <li>- Runoff Coefficient= 0-1 rating depending on extent of imperviousness of upstream catchment area. See Appendix 2 for a table and description on how to calculate this value.</li> <li>- Rainfall Amount= a fixed amount of rainfall expected for specific design storm events. These rainfall amounts are determined utilizing the Ministry of Transportation of Ontario (MTO) online tool found here: <a href="http://www.mto.gov.on.ca/IDF_Curves/terms.shtml">http://www.mto.gov.on.ca/IDF_Curves/terms.shtml</a> Note: copy the rainfall amount values found in Row A of the MTO online tool and place them under the corresponding design storm – return period in the table below:</li> </ul> <table border="1"> <thead> <tr> <th>Design Storm – Return Period</th> <th>5 year</th> <th>10 year</th> <th>25 year</th> <th>50 year</th> <th>100 year</th> </tr> </thead> <tbody> <tr> <td>Rainfall Amount</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Step #2: Calculate the maximum available flood volume storage of the proposed wetland.</p> <p>Volume = <math>(a_1+a_2/2) \times H</math></p> <p>Where:            Volume= total potential wetland flood water storage            a<sub>1</sub>= area of wetland base            a<sub>2</sub>= area of wetland high water mark</p>	Design Storm – Return Period	5 year	10 year	25 year	50 year	100 year	Rainfall Amount					
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	2.1.2 Ground water discharge	25/25	<table border="1"> <thead> <tr> <th>Wetland Characteristic</th> <th>None to Little</th> <th>Some</th> <th>High</th> </tr> </thead> <tbody> <tr> <td><b>Dominant Wetland Type</b></td> <td>Bog = 0</td> <td>Swamp/Marsh = 2</td> <td>Fen = 5</td> </tr> <tr> <td><b>Topography</b></td> <td>Flat/rolling = 0</td> <td>Hilly = 2</td> <td>Steep = 5</td> </tr> <tr> <td><b>Wetland area: upslope catchment area</b></td> <td>Large (&gt;50%) = 0</td> <td>Moderate (5-50%) = 2</td> <td>Small (&lt;5%) = 5</td> </tr> <tr> <td><b>Lagg development</b></td> <td>None = 0</td> <td>Minor = 2</td> <td>Extensive = 5</td> </tr> <tr> <td><b>Seeps</b></td> <td>None = 0</td> <td>Seasonal = 2</td> <td>Permanent = 5</td> </tr> <tr> <td><b>Surface marl deposits</b></td> <td>None = 0</td> <td></td> <td>Present = 5</td> </tr> <tr> <td><b>Iron precipitates</b></td> <td>None = 0</td> <td></td> <td>Present = 5</td> </tr> </tbody> </table>	Wetland Characteristic	None to Little	Some	High	<b>Dominant Wetland Type</b>	Bog = 0	Swamp/Marsh = 2	Fen = 5	<b>Topography</b>	Flat/rolling = 0	Hilly = 2	Steep = 5	<b>Wetland area: upslope catchment area</b>	Large (>50%) = 0	Moderate (5-50%) = 2	Small (<5%) = 5	<b>Lagg development</b>	None = 0	Minor = 2	Extensive = 5	<b>Seeps</b>	None = 0	Seasonal = 2	Permanent = 5	<b>Surface marl deposits</b>	None = 0		Present = 5	<b>Iron precipitates</b>	None = 0		Present = 5	<table border="1"> <thead> <tr> <th>Wetland Characteristic</th> <th>None to Little</th> <th>Some</th> <th>High</th> </tr> </thead> <tbody> <tr> <td><b>Dominant Wetland Type</b></td> <td>Bog = 0</td> <td>Swamp/Marsh = 2</td> <td>Fen = 5</td> </tr> <tr> <td><b>Topography</b></td> <td>Flat/rolling = 0</td> <td>Hilly = 2</td> <td>Steep = 5</td> </tr> <tr> <td><b>Wetland area: upslope catchment area</b></td> <td>Large (&gt;50%) = 0</td> <td>Moderate (5-50%) = 2</td> <td>Small (&lt;5%) = 5</td> </tr> <tr> <td><b>Lagg development</b></td> <td>None expected = 0</td> <td>Minor Lagg expected = 2</td> <td>Extensive Lagg expected = 5</td> </tr> <tr> <td><b>Seeps</b></td> <td>No additional seeps expected = 0</td> <td></td> <td>Additional seeps expected = 5</td> </tr> </tbody> </table>	Wetland Characteristic	None to Little	Some	High	<b>Dominant Wetland Type</b>	Bog = 0	Swamp/Marsh = 2	Fen = 5	<b>Topography</b>	Flat/rolling = 0	Hilly = 2	Steep = 5	<b>Wetland area: upslope catchment area</b>	Large (>50%) = 0	Moderate (5-50%) = 2	Small (<5%) = 5	<b>Lagg development</b>	None expected = 0	Minor Lagg expected = 2	Extensive Lagg expected = 5	<b>Seeps</b>	No additional seeps expected = 0		Additional seeps expected = 5
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	2.1.3 Ground water recharge	25/25	<p>If wetland is located within a municipal well head protection zone the wetland automatically scores 25 points. There is no need to calculate scores below.</p> <p>Wetland Site Type: - Zero points for wetlands greater than 50% lacustrine (by area) or located</p>	<p>If wetland is located within a municipal well head protection zone the wetland automatically scores 25 points. There is no need to calculate scores below.</p> <p>Wetland Site Type: - Zero points for wetlands greater than 50% lacustrine (by area) or located</p>																																																								

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2.2 Water Quality and Carbon Storage	2.2.1 Short-term water quality improvement in wetland	50/50	<p>If wetland is located on a major lake (Huron, St. Clair, Erie, Ontario, Simcoe) or major river (St. Clair, Detroit, Niagara, St. Lawrence, Ottawa) the score is 0 and there is no need to calculate the score below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 1.0 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine wetland on lake shoreline x 0.2 =</li> <li>- Fractional area of lacustrine wetland at lake inflow or outflow x 1.0 =</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of the upstream catchment land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.8</li> <li>- Over 50% forested or other natural vegetation = 0.6</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Fractional area of wetland with live trees, shrubs, herbs or mosses x 0.75 =</li> <li>- Fractional area of wetland with emergent, subemergent or floating vegetation x 1.0 =</li> <li>- Fractional area of wetland with little or no vegetation x 0.5 =</li> </ul> <p>PUF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 4: Calculation of final score</p>	<p>If wetland is located on a major lake (Huron, St. Clair, Erie, Ontario, Simcoe) or major river (St. Clair, Detroit, Niagara, St. Lawrence, Ottawa) the score is 0 and there is no need to calculate the score below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 1.0 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine wetland on lake shoreline x 0.2 =</li> <li>- Fractional area of lacustrine wetland at lake inflow or outflow x 1.0 =</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of the upstream catchment land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.8</li> <li>- Over 50% forested or other natural vegetation = 0.6</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Fractional area of wetland with live trees, shrubs, herbs or mosses x 0.75 =</li> <li>- Fractional area of wetland with emergent, subemergent or floating vegetation x 1.0 =</li> <li>- Fractional area of wetland with little or no vegetation x 0.5 =</li> </ul> <p>PUF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 4: Calculation of final score</p>																														

				- 50 x WIF x LUF x PUF	- 50 x WIF x LUF x PUF
		2.2.2 Short-term water quality improvement in upland buffer	50/50	<p>If buffer is greater than or equal to 50m wide, 50 points are scored and there is no need to complete the calculations below. If no buffer currently exists, 0 points are scored and there is no need to complete the calculations below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 0.8 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine on lake shoreline (all but Major Lakes) x 0.5 =</li> <li>- Fractional area of lacustrine on lake shoreline (Major Lakes) x 0.2</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of adjacent land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.6</li> <li>- Over 50% forested or other natural vegetation = 0.4</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Simple species buffer containing only trees, or shrubs or grasses/forbs = 0.3.</li> <li>- Complex species buffer containing trees, shrubs and grasses/forbs = 1.0.</li> </ul> <p>Step 4: Determination of percent of boundary buffered factor (POBB).</p> <ul style="list-style-type: none"> <li>- 100% of the wetland boundary on the subject property is buffered = 1.0.</li> <li>- 50-99% of the wetland boundary on the subject property is buffered = 0.5.</li> <li>- &lt;50% of the wetland boundary on the subject property is buffered = 0.2</li> </ul> <p>Step 5: Determination of the width factor (WF).</p> <ul style="list-style-type: none"> <li>- 15m to less than 50 m wide = 1.0</li> <li>- 10m to less than 15 m wide = 0.8</li> <li>- 5m to less than 10 m wide = 0.6</li> <li>- Less than 5 m wide = 0.4</li> </ul> <p>Step 6: Determination of steepness factor (SF)</p> <ul style="list-style-type: none"> <li>- Less than 5% = 1.0</li> <li>- 5% to less than 10% = 0.8</li> <li>- 10% to less than 15% = 0.6</li> <li>- Greater than 15% = 0.4</li> </ul> <p>Step 7: Determination of soil texture factor (STF)</p> <ul style="list-style-type: none"> <li>- Sand = 1.0</li> <li>- Loam = 0.7</li> <li>- Clay = 0.4</li> </ul> <p>Step 8: Calculation of final score</p> <ul style="list-style-type: none"> <li>- 50 x WIF x LUF x PUF x POBB x WF x SF x STF</li> </ul>	<p>If buffer is already or proposed to be greater than or equal to 50m wide, 50 points are scored and there is no need to complete the calculations below. If no buffer is proposed a score of 0 points is awarded and there is no need to complete the calculations below.</p> <p>Step 1: Determination of watershed improvement factor (WIF)</p> <ul style="list-style-type: none"> <li>- Fractional area of isolated wetland x 0.5 =</li> <li>- Fractional area of riverine wetland x 0.8 =</li> <li>- Fractional area of palustrine wetland with no inflow x 0.7 =</li> <li>- Fractional area of palustrine wetland with inflow x 1.0 =</li> <li>- Fractional area of lacustrine on lake shoreline (all but Major Lakes) x 0.5 =</li> <li>- Fractional area of lacustrine on lake shoreline (Major Lakes) x 0.2</li> </ul> <p>WIF Score = sum of the above (cannot exceed 1.0)</p> <p>Step 2: Determination of adjacent land use factor (LUF)</p> <ul style="list-style-type: none"> <li>- Over 50% agricultural and/or urban = 1.0</li> <li>- Between 30 and 50% agricultural and/or urban = 0.6</li> <li>- Over 50% forested or other natural vegetation = 0.4</li> </ul> <p>Step 3: Determination of pollutant uptake factor (PUF)</p> <ul style="list-style-type: none"> <li>- Simple species buffer containing only trees, or shrubs or grasses/forbs = 0.3.</li> <li>- Complex species buffer containing trees, shrubs and grasses/forbs = 1.0.</li> </ul> <p>Step 4: Determination of percent of boundary buffered factor (POBB).</p> <ul style="list-style-type: none"> <li>- 100% of the wetland boundary on the subject property is buffered = 1.0.</li> <li>- 50-99% of the wetland boundary on the subject property is buffered = 0.5.</li> <li>- &lt;50% of the wetland boundary on the subject property is buffered = 0.2</li> </ul> <p>Step 5: Determination of the width factor (WF).</p> <ul style="list-style-type: none"> <li>- 15m to less than 50 m wide = 1.0</li> <li>- 10m to less than 15 m wide = 0.8</li> <li>- 5m to less than 10 m wide = 0.6</li> <li>- Less than 5 m wide = 0.4</li> </ul> <p>Step 6: Determination of steepness factor (SF)</p> <ul style="list-style-type: none"> <li>- Less than 5% = 1.0</li> <li>- 5% to less than 10% = 0.8</li> <li>- 10% to less than 15% = 0.6</li> <li>- Greater than 15% = 0.4</li> </ul> <p>Step 7: Determination of soil texture factor (STF)</p> <ul style="list-style-type: none"> <li>- Sand = 1.0</li> <li>- Loam = 0.7</li> <li>- Clay = 0.4</li> </ul> <p>Step 8: Calculation of final score</p> <ul style="list-style-type: none"> <li>- 50 x WIF x LUF x PUF x POBB x WF x SF x STF</li> </ul>
		2.2.3 Long-term nutrient (nitrogen/phosphorus) trap in wetland	50/50	<ul style="list-style-type: none"> <li>- No wetland present = zero points</li> <li>- Wetland does not have permanent open water = 10 points</li> <li>- Wetland does have permanent open water = 20 points</li> <li>- Wetland is located in a river mouth = 50 points</li> </ul>	<ul style="list-style-type: none"> <li>- Add zero points to the existing condition score if the proposed wetland is not located in a river mouth and does not intend to have permanent open water or does not intend to add to the extent of permanent open water</li> <li>- Add 20 points to the existing condition score if the proposed wetland is</li> </ul>

					not located in a river mouth and does intend to add to the extent of the permanent open water - Wetland will be located in a river mouth = 50 points
		2.2.4 Shoreline erosion control	25/25	Step 1: Wetland entirely isolated = zero points Any part of the wetland palustrine, riverine or lacustrine (proceed to Step 2) Step 2: Calculate the shoreline vegetation fractional area and multiply by the points indicated below. For diversely vegetated shorelines sum points to a maximum of 25. - Fractional area of trees and shrubs x 25 points - Fractional area of emergent vegetation x 12 points - Fractional area of submergent vegetation x 9 points - Fractional area of other shoreline vegetation x 6 points - Fractional area of no vegetation x zero points	Step 1: Wetland entirely isolated = zero points Any part of the wetland palustrine, riverine or lacustrine (proceed to Step 2) Step 2: Calculate the shoreline vegetation fractional area and multiply by the points indicated below. For diversely vegetated shorelines sum points to a maximum of 25. - Fractional area of trees and shrubs x 25 points - Fractional area of emergent vegetation x 12 points - Fractional area of submergent vegetation x 9 points - Fractional area of other shoreline vegetation x 6 points - Fractional area of no vegetation x zero points
		2.2.5 Carbon Storage	15/25	- Wetland does not have permanent open water = 5 points - Wetland does have permanent open water = 15 points	- Add zero points to the existing condition score if the proposed wetland does not intend to have permanent open water or does not intend to add to the extent of the existing permanent open water - Add 10 points to the existing condition score if the proposed wetland does intend to add to the extent of the permanent open water
		<b>Subtotal</b>	<b>190/200</b>		
		<b>TOTAL</b>	<b>315/325</b>		
<b>3.0 Social</b>	3.1 Goods	3.1.1 Sustainable use of the wetland for harvesting goods	0/25	- Not applicable	- Zero points for no harvesting of food, fuel and/or fibre or allow harvesting without ensuring best management practices are followed (i.e. do not have a Managed Forest Plan, do not use licensed hunters, anglers or trappers). - 25 points for allowing the harvesting of food, fuel and/or fibre and ensure that best management practices are followed (i.e. fuel and fibre wood harvested in accordance with a Managed Forest Plan and licensed hunters, anglers and trappers utilized to harvest pelts).
				Notes: - If the timber associated with the wetland is immature at the moment and the Managed Forest Plan does not call for a thinning within the next 10 years award 25 points if the landowner intends to allow timber harvesting in subsequent Managed Forest Plan updates - If fish are harvested, points are to be scored here and not within the Recreation Sub-Component - Due to the devastating impacts to wetland quality, peat extraction is not recognized as a public good scored in this tool	
	<b>Subtotal</b>		<b>0/25</b>		
	3.2 Recreation	3.2.1 Sustainable use of the wetland for recreation	0/25	- Not applicable	- Zero points for no public allowance - 10 points for public allowance on an infrequent situation by situation (daily) basis. - 20 points for public allowance on a more frequent (long-standing) informal basis. - 25 points for year round formalized access (i.e. Bruce Trail crosses the property)
Notes: - Example recreation activities eligible for points include: catch and release fishing, hiking, bird watching and nature enjoyment - If angling is catch and release only, points are to be scored here and not within the Goods Sub-Component					

	<b>Subtotal</b>		<b>0/25</b>		
	3.3 Aesthetics	3.3.1 Landscape aesthetics	25/25	<ul style="list-style-type: none"> <li>- Zero points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is not distinctly recognizable on the landscape</li> <li>- 10 points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is distinctly recognizable on the landscape</li> <li>- 20 points for wetland less than 120m from a public road/trail/navigable waterway or neighbouring property</li> <li>- 25 points for wetland that is immediately adjacent a public road/trail/navigable waterway or neighbouring property</li> </ul>	<ul style="list-style-type: none"> <li>- Zero points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is not distinctly recognizable on the landscape</li> <li>- 10 points for wetland greater than or equal to 120m from a public road/trail/navigable waterway or neighbouring property and wetland is distinctly recognizable on the landscape</li> <li>- 20 points for wetland less than 120m from a public road/trail/navigable waterway or neighbouring property</li> <li>- 25 points for wetland that is immediately adjacent a public road/trail/navigable waterway or neighbouring property</li> </ul>
	<b>Subtotal</b>		<b>25/25</b>		
	3.4 Education and Research	3.4.1 Use of wetland for education and/or research activities	0/25	- Not applicable	<ul style="list-style-type: none"> <li>- Zero points for no public allowance.</li> <li>- 10 points for minimal public allowance on an infrequent situation by situation (daily) basis</li> <li>- 20 points for public allowance on a more frequent (ongoing) basis</li> <li>- 25 points for public allowance on a more frequent (ongoing) basis and landowner is willing to participate in education and research activities</li> </ul>
	<b>Subtotal</b>		<b>0/25</b>		
	3.5 Cultural and Aboriginal Values	3.5.1 Enhancement to the historical, religious and/or spiritual value	0/25	- Not applicable	<ul style="list-style-type: none"> <li>- Zero points for no enhancements to the historical, national, religious or spiritual value of the wetland</li> <li>- 25 points for a documented enhancement to the historical, national, religious or spiritual value of the wetland</li> </ul>
				<p>Notes:</p> <ul style="list-style-type: none"> <li>- Applicants are encouraged to contact local First Nations and historical societies to determine site significance</li> <li>- Example activities eligible for points include: interpretive signage (e.g. sign informing visitors of a historic trade route through the wetland or preservation of a historical dam), public use of the wetland for religious ceremonies, or presence of sacred sites or use of the wetland for song, chant and/or stories</li> </ul>	
	<b>Subtotal</b>		<b>0/25</b>		
	<b>TOTAL</b>		<b>25/125</b>		
	<b>GRAND TOTAL</b>		<b>544/733</b>		

## APPENDIX 2: RUNOFF COEFFICIENTS

Land Use	A			B			C			D		
	0-2%	2-6%	6% <sup>a</sup>	0-2%	2-6%	6% <sup>a</sup>	0-2%	2-6%	6% <sup>a</sup>	0-2%	2-6%	6% <sup>a</sup>
Cultivated land	0.08 <sup>a</sup>	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14 <sup>b</sup>	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.15	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97

<sup>a</sup> Runoff coefficients for storm recurrence intervals less than 25 years.

<sup>b</sup> Runoff coefficients for storm recurrence intervals of 25 years or longer.

Source:

[http://www.utdallas.edu/~brikowi/Teaching/Applied\\_Modeling/SurfaceWater/LectureNotes/Rational\\_Method/Runoff\\_Coefficient.html](http://www.utdallas.edu/~brikowi/Teaching/Applied_Modeling/SurfaceWater/LectureNotes/Rational_Method/Runoff_Coefficient.html)

Notes:

- A, B, C, D refers to catchment soil type. A=Sandy Soil, B=Sandy Loam Soil, C= Clay Loam Soil, D=Clay Soil.
- 0-2%, 2-6% and greater than 6% refers to catchment slope