# A Wetland Conservation Strategy for London:

## A Discussion Paper on Best Practices

Recommendations for the City of London and
Our Development Partners

Prepared for the City of London by the
Ecological and Environmental Planning Advisory Committee (EEPAC)

## 1 Introduction

Wetlands are among the most ecologically diverse and productive ecosystems in the world, rich in biodiversity, providing habitat for many species and render many ecological services . While wetlands cover only 1.5 percent of the Earth's surface, they account for 40 percent of the world's ecosystem services, including water purification, sediment trapping, nutrient cycling, temperature regulation, and reducing flood and erosion risks. Although wetlands are among the most important ecosystems on the planet, they are one of the most threatened due to human activities—urbanization, economic development, and climate change (Pattison-Williams et al., 2017). Wetland loss and degradation around the world has occurred at an alarming rate; over 64 percent of the world's wetlands have disappeared in a little over a century (Pattison-Williams et al., 2017).

Russia and Canada are home to the largest wetland areas. Canada's wetlands are diverse, consisting of marshes, bogs, fens, swamps and open water. However, approximately twenty million hectares of the nation's wetlands have been drained for agricultural purposes since European settlement, totalling approximately a 70 percent loss from historical highs (Pattison-Williams et al., 2017). Currently, wetlands in Ontario cover 350,000 square kilometres, comprising 25 percent of all the wetlands in Canada and six percent of the world's wetlands (A Wetland Conservation Strategy, p.2). These seemingly large numbers disguise the fact that much of Ontario's wetlands have been lost, and the losses have been severe in the most densely populated areas—precisely the areas that most require robust wetland policy and protection. In the 19th century, 25 percent of southern Ontario's terrestrial area (two million hectares) consisted of wetlands. By 2002, 72 percent of the wetlands in southern Ontario (1.4 million hectares) had been lost primarily due to agriculture and expanding urban and suburban development (Ducks Unlimited, p. 1). From 1982 until 2002, southern Ontario lost another 3.5 percent of its pre-settlement wetlands, equalling 70,854 hectares, at an average of 35 km2 per year, an area the size of St. Thomas (Ducks Unlimited, 2010, p.1).

Until recently, our understanding of wetlands — and the services and functions they provide — was limited. Wetlands were often considered insect-infested wastelands, and as such land use policies have not — and still do not— prioritize their conservation. Since they are not currently valued by the market system and financial incentives to protect them are lacking, wetlands have been, and are continuously, drained and/or filled in for roads, agricultural use, housing developments, new shopping complexes, or to serve as waste sites. As London expands in population and area, the City's wetlands are likewise facing consistent pressure as private and public construction projects are proposed. This document is prepared to facilitate the City and all stakeholders who are involved in development projects to ensure that development projects and other works do not negatively impact the City's wetlands or lead to their complete loss.

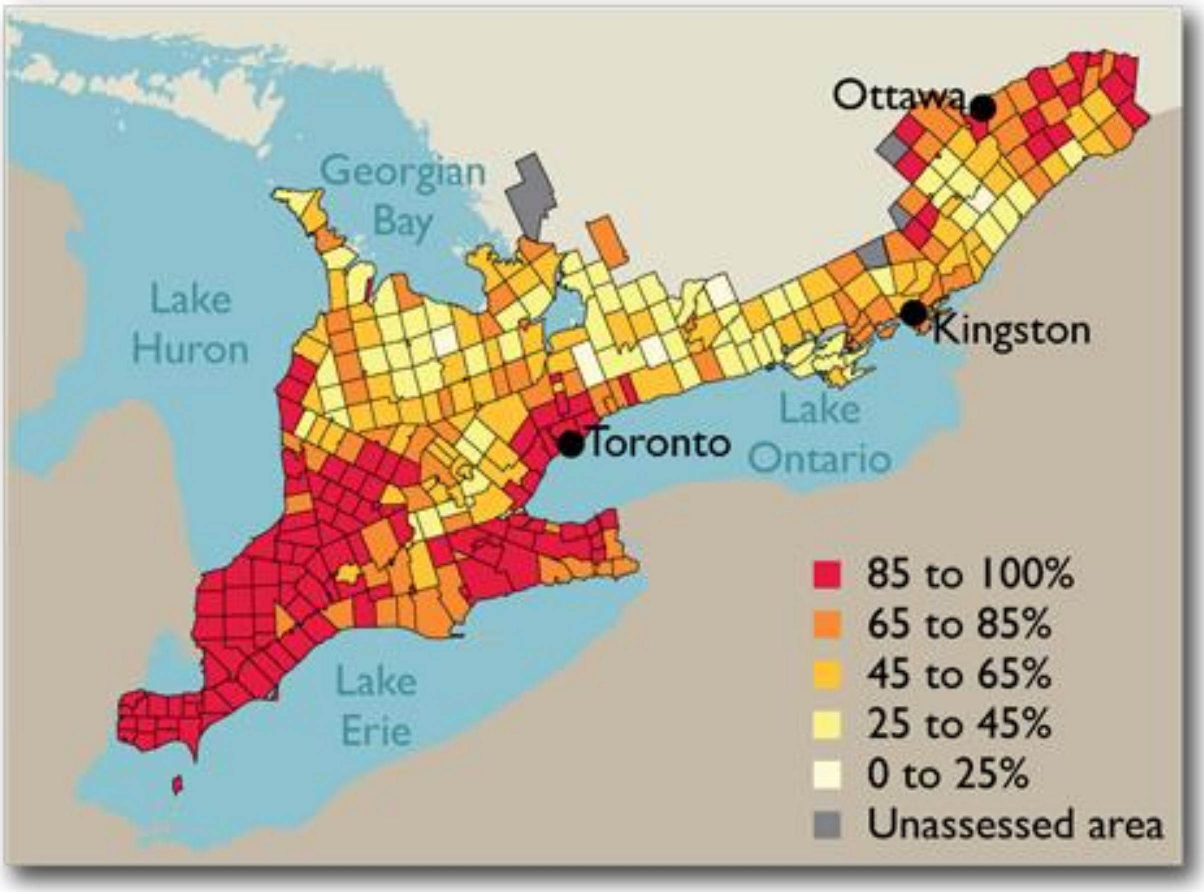


**Figure 1.** Wetland losses in southern Ontario (1880-2002). In southwestern Ontario, the loss of wetlands has been the most dramatic, with over 85 percent of the areas originally covered in wetlands converted to other uses.

## 2 Definitions

### 2.1 Types of Wetlands

- **Bog** — A wetland with acidic soils that may or may not have trees, with waterlogged soils — fed solely by precipitation — that tend to accumulate peat and is associated with low productivity. They are often very old, perhaps thousands of years. Bogs often have a low diversity of species. Rare in southern Ontario.
- **Fen** — A wetland dominated by grasses, sedges and rushes that may or may not have trees, with waterlogged soils that tend to accumulate peat. Fens are fed by groundwater and surface water runoff, and are associated with low productivity. Rare in southern Ontario.
- **Marsh** — A wetland without trees, associated with flowing water, and tends to be highly productive. Dominated by non-woody plants such as cattails, rushes, pond lilies and submerged plants.
- **Swamp** — A wetland with trees, associated with flowing water, and tends to be highly productive.
- **Wetland** — An ecosystem which is seasonally or permanently covered in standing water or saturated with water for a least part of the year, or where the water table is close to or at the surface, such that vegetation has adapted for growth in saturated conditions.

### 2.2 Ecology and Development Terms

- **Additionality** — The degree to which an offsetting project generates new and additional contributions to biodiversity conservation/wetland conservation.
- **Biodiversity Offsetting** — Compensating (or attempting to compensate) for losses of biodiversity at an impact site by either creating ecologically equivalent gains or credits at an in-site or off-site location. The purpose of biodiversity offsetting is to incur no-net loss of biodiversity.
- **Invasive Species** — a non-native species that outcompetes native species and becomes a nuisance or threat to ecosystems.
- **LID** — [Low Impact Development] Land planning and engineering design approach considering conservation and on-site nature protection to manage stormwater runoff as part of green infrastructure.
- **Mitigation Banking** — The developer purchases offset credits from a wetland bank, that is, an area that has been previously restored, created, enhanced or preserved and set aside by a third

party, and certified for compensation. The banker is responsible for the success of the compensation project.

- **Mitigation Hierarchy** — A tool used in biodiversity offsetting to minimize the harm that occurs due to a project. The preference should be given first to avoiding negative impacts, then to minimizing impacts at a project site, followed by restoration/rehabilitation and finally, offsetting biodiversity losses that cannot be avoided.
- **Rehabilitation/Creation/Re-creation** — Bringing back once-existing wetlands
- **Restoration** — Bringing back areas degraded through actions such as in-filling, changes in drainage patterns, sedimentation, vegetation removal, and pollution.
- **Urban Heat Island Effect** — When an urban or metropolitan area is significantly warmer than rural areas due both to human activities and the built environment.
- **Wetland Offsetting** — Compensation for the negative impacts of development through the restoration or creation of new wetlands to achieve no-net-loss or a net environmental gain.

# 3 Wetlands: Structure, Biology and Function

Wetlands can range in size from very small (a few square metres) to hundreds of square kilometres. Wetlands may be isolated, occur along the edges of lakes and rivers, or exist in conjunction with other natural areas such as woodlands, shrublands and native grasslands. In some cases, closely spaced wetlands related in a functional way can also form a wetland complex. In southern Ontario the average wetland is 25 hectares and the majority are swamps, dominated by trees and shrubs.

Wetland types are recognizable by their indicator and keystone species.

**Table 1:** Common keystone and indicator plant species in Southwestern Ontario's Wetlands

| Species | Habitat Types | Habitat requirements |
|---|---|---|
| Broadleaf cattail<br>*Typha latifolia* | Marshes<br>Bogs<br>Fens | ommon resident of the marsh environment<br>ially one of the first species to colonize new habitats<br>quires full sunlight<br>eds germinate in acidic, neutral or basic pH, but only in shallow water<br>Seeds will also germinate in low oxygen conditions<br>Cattails can occur in sand, silt, loam and clay substrates |
| Small-fruited bulrush<br>*Scirpus microcarpus* | Marshes<br>Fens | A common resident of the marsh environment<br>Tolerates both full-sunlight and shade<br>Requires silty/mucky soil with a high water-holding capacity<br>Grows best in neutral pH, but can also grow in acidic conditions |
| Soft maples<br>*Acer saccharinum,*<br>*Acer rubrum* | Swamps | Commonly found along the edges of swamps<br>Tolerant to waterlogged soils and flooding<br>Tolerate sun or shade and in all soil types<br>They can thrive in acidic, neutral and basic pH conditions |
| Black spruce<br>*Picea mariana* | Bogs<br>Swamps | This species is indicative of a bog environment<br>Also found in coniferous swamps<br>Tolerant of highly acidic soils and is most abundant in peat bogs<br>A pioneer species in bogs and can invade the *Sphagnum* spp. mat<br>Grows well in a variety of soils, moisture levels and light conditions |

## 3.1 Wetlands: Vital for species richness and abundance

While the economic benefits of wetlands tend to focus on flood control and water purification, wetlands provide other irreplaceable ecological services. One of the economically unappreciated features of wetlands is their contribution to biodiversity conservation and maintenance of the web of life. Since marshes and swamps are usually shallow enough to allow sunlight to penetrate and to allow for seasonal warming, they support high levels of photosynthetic activity, making them highly productive areas, full of diverse and abundant species. In Ontario, wetlands are biodiversity hotspots, supporting a variety of plants, birds, insects, amphibians and fish, and are particularly valuable to migratory water and shore bird species for breeding and nesting.

Wetlands are also a home to a number of Ontario's species at risk (SAR).

**Table 2:** Species at risk that occur in London's wetlands

| Species | • Status in Ontario | • Habitat type | Habitat requirements | Threats |
|---|---|---|---|---|
| Eastern Ribbonsnake *Thamnophis sauritus* | • Special concern | • Marshes<br>• Fens<br>• Bogs<br>• Swamps | • Found in areas with permanent water near terrestrial habitat (Harding 1997; Schribner and Weatherhead 1995) with shallow water and low, dense shoreline vegetation (Minton 1992; Cosewic 2002)<br>• Habitat includes bare substrate near wetlands including gravel, cobble and boulders (Desroches and Leparé 2004).<br>• Habitats used by Eastern ribbonsnakes must have a high abundance of amphibians, particularly frogs, as these are their primary food source (Carpenter 1952; Brown 1979; COSEWIC 2012). | • Their biggest threats are loss of habitat including loss of wetland and riparian habitat (Environment Canada 2015). |
| • Eastern prairie fringed orchid<br>• *Platanthera leucophaea* | Endangered | • Marshes<br>• Fens<br>• Swamps | • Requires open conditions with full sunlight and is restricted to graminoid-dominated vegetation communities (Bowles 1993).<br>• It requires soil that is neutral to slightly calcareous (Bowles et al. 2005, Case 1987, Bowles 1983) and can tolerate pHs of between 5.3 and 7.5 (Zambrana Engineering Inc. 1998).<br>• The eastern fringed-orchid is adapted to fluctuations in water levels (COSEWIC 2003) | The largest threats to the orchid are the lack of suitable habitat due to its specific habitat needs as well as habitat loss and degradation (Eastern Prairie Fringed-orchid Recovery Team 2010) |

## 3.2 Wetland: Nature's water quality regulators

Wetlands are vital for human health and safety, through their ability to control flood waters, protect against natural disasters, and mitigate and adapt to climate change. The natural water purification system within wetlands removes silt and sediments, preventing them from entering rivers. The wetland-retained sediments gather nutrients and help form fertile agricultural land. Chemical reactions in wetlands can detoxify some substances in the water, thereby protecting us from pollution. As more of the City's land is transformed with impervious covers of asphalt, concrete, and rooftops, rainwater run-off becomes increasingly severe. As such, London's remaining wetlands become progressively important for flood management and water purification. In a city like London, that is surrounded by agricultural land, preserving and expanding our wetlands would help remove organic material, particularly phosphorus and nitrogen (resulting from fertilizer runoffs) from entering our streams, rivers and lakes. These wetland functions are not just 'nice' – they provide essential ecosystem services and have real economic benefits for society as a whole.

Wetlands also alleviate drought by holding water when conditions are dry. Water accumulated in wetlands seeps into the ground, helping to replenish underground aquifers. Wetlands work to mitigate climate change by absorbing greenhouse gases, acting as carbon sinks that stabilize climate conditions. In London, the City's wetlands lessen the urban heat island effect, which will become increasingly important as temperatures rise.

## 4. Wetland Conservation

Currently, land conversion is the biggest threat to wetlands in southern Ontario. Urban pressures are driving up the price of land, making land markets highly competitive, which ultimately leads to significant rates of wetland conversion (Lantz et al., 2013). Ecosystem services provided by wetlands — considered free, common goods—are routinely omitted in the market prices of projects. Consequently, wetland loss or disturbance is rarely given adequate consideration in land-use planning decisions. London, as a growing and dynamic city, is faced with the persistent challenge of balancing expanding city infrastructure and conserving its ecosystems, especially wetlands. In recent years, several development projects have affected local wetlands and it is anticipated that many more such ventures will arise. Consequently, the City of London requires a clear set of guidelines governing development projects, such as housing plans and expanded transportation infrastructure, to avoid disturbance, reduce impacts and mitigate unavoidable damage to wetlands.

### 4.1 Legislative Background

The following section provides only a brief snapshot of relevant international, national and municipal regulations that govern wetlands and their conservation. Appendix 3 provides a more indepth, though not exhaustive, list of pertinent laws. Most nations have recognized the need to preserve wetlands. Internationally, their protection is governed by the Ramsar Convention, a treaty for the conservation and sustainable use of wetlands, signed in 1971, ratified in 1975 and adopted by Canada in 1982. A subsequent Working Group on Criteria and Wise Use of wetlands clarified the terms "sustainable utilization" as found in Article 3 of the Ramsar Convention as "human use of a wetland so that it may yield the greatest continuous benefit to present generations whilst maintaining its potential to meet the needs and aspirations of future generations" (Birnie and Boyle, 2002, p. 618). This Working Group also confirmed that activities involving wetlands should be governed by the *precautionary principle*, and argued that when complete knowledge is lacking regarding the outcomes of an activity, that activity should be prohibited (Birnie and Boyle, 2002).

*Provincial Legislation*. Ontario, influenced by international conventions and agreements, is moving forward with a strategy to stop wetland loss and to restore wetlands where the largest losses have occurred. Guided by "A Wetland Conservation Strategy for Ontario 2017-2030", the province is striving for a social and political climate where "Ontario's wetlands and their functions are valued, conserved and restored to sustain biodiversity and to provide ecosystem services for present and future generations" (A Wetland Conservation Strategy for Ontario, 2017, p. iii). The strategy comprises two targets: the net loss of wetland area and function will stop by 2025, and a net gain in wetland area and function will occur by 2030. The Strategy also puts forth the principle that wetlands should be conserved according to three hierarchical priorities — protect (retain area and functions of wetlands), mitigate (minimize further damage), and restore (improve and re-establish wetland area and function). Most significantly, the above mentioned document calls for a *precautionary approach* regarding wetlands and development projects, in keeping with the Ramsar Convention.

The 2014 *Provincial Policy Statement (PPS)* is central to provincial wetlands conservation. It asserts that our natural heritage is a resource: "The Province must ensure that its resources are managed in a sustainable way to conserve biodiversity, protect essential ecological processes and public health and safety, provide for the production of food and fibre, minimize environmental and social impacts, and meet its long-term needs" (PPS, p.4). The purpose of the provisions within the PPS is to protect "natural features and areas… for the long-term" (PPS, p.22). The PPS clearly states that "[t]he diversity and connectivity of natural features in an area, and the long-term *ecological function* and biodiversity of *natural heritage systems,* should be **maintained**, **restored** or, where possible, **improved**, recognizing linkages between and among *natural heritage features and areas, surface water features,* and *groundwater features*" (PPS 2.1.2, bold added). The policies contained within the PPS are minimum standards only; planning authorities and decision-makers are free to take more stringent measures regarding conservation.

Given the interconnectedness of wetlands with other areas of environmental protection, such as biodiversity conservation and climate change, wetlands and their preservation appear in several other provincial documents, Two examples are: "Biodiversity: It's in our Nature" (2011) and "Climate Ready: Ontario's Adaptation Strategy and Action Plan, 2011-2014". Significant statements within these documents pertain to the importance of wetlands for climate change mitigation and adaptation, as well as for their role in ensuring the survival of Ontario's endangered and threatened species. For the purposes of this document, it is necessary to note that all departments concerned with various areas of conservation recognize the importance of preserving our wetlands.

*Municipal Policies: The London Plan*. Land use planning has the greatest influence on the conservation of wetlands. Official plans, local decisions on land use, and community-based land use plans have far reaching impacts on the green spaces of our City, and how the City moves forward with approval for development projects that conflict with conservation values. *The London Plan* has clear provisions for the "identification, protection, conservation, enhancement, and management of our Natural Heritage System" (1293.1). Of particular importance for London as it considers **the retention of its wetlands, no matter how small** (bold added), is *The London Plan* paragraph 1301 which employs the same wording as article 2.1.2 of the *Provincial Policy Statement* noted above. *The London Plan* likewise specifies that no development or alteration shall occur in provincially significant wetlands (PSW) as evaluated and confirmed by the Ministry of Natural Resources and Forests (MNRF), designating them instead as Green Space (*The London Plan,* 1332, 1333, 1390[1]). This provision is in accordance with the *Provincial Policy Statement*.

Notes:
[1] These paragraphs do not specify that the wetland must be "provincially significant" nor do they qualify 'wetland' with a size.

[2] Clause 1334 does suggest an opening for relocation and/or offsetting disturbed wetlands, but without specifications on how these projects should be undertaken or monitored. These guidelines will attempt to fill this gap.

## 4.2 Restoration: Re-establishment and Rehabilitation

Restoration of wetlands can take two forms: "re-establishment" -- returning the natural or historic function of a former wetland with the goal of increasing wetland area -- and "rehabilitation" -- repairing the natural or historic functions of a wetland, such that there is an increase in functions but no increase in the remaining wetland area (McKenney and Kiesecker, 2010).

Restoration ecology is a relatively young discipline. Consequently, insufficient evidence is currently available to demonstrate definitive success in either rehabilitation or re-establishment. Analysis of the hydrologic structure of restored or created wetlands usually only proceeds for one to fifteen years after the project is undertaken, therefore the long-term effects are unknown (Moreno-Mateos et al., 2012). Still, restoration ecologists are increasingly recognizing that, given ecosystems' complexity, restoring or (re)creating one to some specified state, especially within a short time frame, is not feasible (Hobbs et al., 2011 in Maron et al., 2012). Restoration and creation of plant assemblages, particularly woody vegetation, is a lengthy process, and the actual composition of the plants may differ. Opportunistic invasive or non-native species may quickly colonize a disturbed area, outcompeting native species, thereby altering the plant assemblage as it compares to reference sites. Indeed, wetlands are particularly vulnerable to invasive species due to their interconnection with waterways, their proximity to roads (paths along which invasive species may travel), and climate change, which puts stress on wetlands as a result of changing weather patterns (increased rainfall and/or drought). Wetlands are constantly adjusting to disturbances occurring within them and within the surrounding landscape.

An average of thirty years is necessary for restored or created wetland sites to converge with the reference states of wetlands. However, the soil composition, chemical properties and ecosystem functions (i.e. nutrient cycling) may take significantly longer to recover (Maron et al., 2012). Even after a century, wetlands on average only operate at 75 percent functionality compared to reference sites (Moreno-Mateos et al., 2012). Restoration can prove even more difficult due to challenging situations occurring outside of the site, such as continued urbanization or new development projects that exert negative influences on the restoration site (Maron et al., 2012). Stranko et al. (2012) looked at the effectiveness of stream restoration in urban areas and found that these restoration activities failed to improve any of eight biodiversity indices. The authors determined that the impacts of urbanization on stream ecology are irreversible and consequently it is unlikely that any biodiversity gains can come from stream restoration projects in urban areas (Maron et al., 2012). The same is likely true of wetlands -- and particularly small wetlands -- in urban settings.

## 4.3 Relocation or Creation as a Means to Conserve Wetlands

Wetland creation — construction of a wetland where one did not previously exist — is much more complicated than restoration, with less potential for success. it is not recommended as a solution to allowing an existing wetland to be destroyed.

Wetland relocation (a compensation plan) is considered when the wetland feature is not categorized as provincially or municipally significant -- or significant wildlife habitat is not confirmed -- yet the wetland feature provides productive amphibian breeding habitat and habitat for terrestrial crayfish. **Under *The London Plan*, all wetlands, regardless of size, are to be protected under the natural heritage system policies. In each case where a wetland is slated to be relocated or altered, the City must consider the merits of destroying the functionality of that wetland and replacing it with a wetland which may only operate at 75 percent functionality (in the best-case scenario), or which may shift to an alternate wetland type**. In such cases, the City must ascertain whether the existing or replacement function is more important, whether the proposed wetland will increase wetland diversity, and whether the potential for increased biodiversity is worth any loss to habitat of endangered species resulting from the project (Kentula, 2002). The more complex the hydrology or the ecological system, the more difficult it is to restore a wetland completely; in many cases it may be impossible.

If the wetland functions can be replicated, a similar habitat is created elsewhere on the subject lands and target wildlife are gathered and trapped from the wetland habitat lost due to the development project and transported to the compensation wetland. Before relocating or creating a new wetland, the impacted wetland should be examined within a larger landscape and social context to determine what roles it plays within the ecosystem/social structure. For instance, is the current wetland a stop on a migratory route? Does it contribute to the watershed levels? It is necessary to look beyond municipal boundaries, which are artificial limits when applied to ecosystems.

## 4.4 Precaution and Preservation Over Relocation

Preservation should be the top priority since restoration, relocation and recreation projects seldom meet targets. To date, research has demonstrated that restoration and relocation projects are slow to produce results. Indeed, restoration ecologists have been unable to re-create full functional replacement; it may not even be possible to fully re-create all the functions of a wetland. As Poulton and Bell noted, "[nowhere is there a resounding success story, where offsetting has been demonstrated to achieve its full potential" (Poulton and Bell, 2017, p. i). In a study by Suding (2011), reviewing global successes and failures of restoration projects, it was found that only one-third to one-half of projects were successful where restoration was used to fix a degraded system, and that when restoration was used to re-create a habitat, the success rate was even lower (Maron et al., 2012). Re-vegetated areas on highly degraded sites rarely resemble the target ecosystem (Maron et al., 2012). In a meta-analysis of restored wetland systems around the world by Moreno-Mateos et al. (2012), it was discovered that even after a century, the biological structure (i.e. plant assemblages) and biogeochemical functioning (storage of carbon in wetland soils) was on average 26 percent and 23 percent lower, respectively, than reference sites. These findings support that case that wetland offsetting should be used as a last resort in the mitigation sequence.

International, national and provincial legislation and policies stress the importance of employing the *precautionary principle* in regard to environmental problems. This principle should be applied more rigorously when wetlands are concerned, due to our limited knowledge of their functions and processes. Instead, too much stock is placed on the ability of restoration, relocation and recreation of wetlands to recover lost biodiversity (Maron et al., 2012). This misguided faith has led to further biodiversity loss, as decision-makers, believing that restoration can deliver equivalent or better results, approve development projects that promise to damage ecosystems and functions. The technical success of offsets is seriously limited due to time lags and problems with the measurability of the value being offset (Maron et al., 2012). Therefore, the *precautionary principle* should prevail.

# 5. Conclusion: Ensuring the future of London's wetlands

"Natural ecosystems provide the foundation of a functioning human society" (Pattison-Williams et al., 2017, p. 400).

Wetlands are an important natural heritage feature of our city. They provide habitat, shelter and food sources for local species, a variety for ecosystem services such as flood control and water filtration, and opportunities for recreation and nature enjoyment for the community. Indeed, people must have access to a good natural and cultural environment, rich in biological diversity, as a basis for health, quality of life and well-being. As London continues to grow in population and area, every effort should be made to preserve natural areas within the city limits, and where future development projects affect a wetland, the precautionary principle should be upheld. Better scientific understanding of biotic and abiotic factors that hamper the success of relocation projects is necessary before London embraces offsetting and relocation as a means to compensate for losses stemming from development and urban expansion. The risk always exists that the offset never achieves an equivalent conservation value; ecologists have expressed concern that biodiversity offsetting exchanges "certain losses for uncertain gains" (Maron et al., 2012).

The principle of protecting "natural features and areas … for the long-term" found in the *Provincial Policy Statement* must be remembered during the analysis of development proposals. When considering the merits of a project proposal, City staff, the City Council and developers should take a broad look at the effects of the works beyond the narrow development site to the broader functioning of ecosystems within the city. The PPS and the *London Plan* clearly state that "[t]he diversity and connectivity of natural features in an area, and the long-term *ecological function* and biodiversity of *natural heritage systems,* should be **maintained**, **restored** or, where possible, **improved**, recognizing linkages between and among *natural heritage features and areas, surface water features,* and *groundwater features*" (PPS 2.1.2; London Plan, 1301, bold added). The City must return to this provision each time a project considers removing, altering or otherwise damaging a wetland.

According to the mitigation hierarchy, preservation or avoidance of harm should always be the first priority. Wetlands are afforded even greater protection under any offsetting policy, with greater multiplier ratios due to the recognition of the vital ecosystem services they provide, and the realization that wetland areas have already declined dramatically. **Consequently, in London, preservation of our wetlands, no matter their size, should be paramount.** The possibility of relocating a wetland for a development project should not be used as an excuse to undertake that project, when avoidance of disturbance is equally an option. Economic concerns should not be given greater weight than environmental concerns where wetlands are affected.

## Part 2: Wetland Offsetting: Relocating London's Small Wetlands

(conservation through relocation)

### 1. Introduction to Offsetting

Ontario is looking towards offsetting as one option to prevent the net loss of wetlands. Wetland offsetting involves mitigating negative impacts upon one wetland by intentionally restoring or creating a new wetland at a different location. This type of policy is typically set within a mitigation hierarchy and involves the hierarchical progression of alternatives, including avoidance of impacts, minimization or mitigation of avoidable impacts and offsetting of impacts that cannot be avoided. Recently offsetting has become a popular approach to balance development projects with the need to protect biodiversity. It is meant to ensure no net loss, and, ideally, a net gain of biodiversity. However, it must be made clear that offsetting will not replace other legislation that provides protection for certain wetlands (i.e. provincially significant wetlands) where disturbance is prohibited.

Accepted methods of compensation include wetland restoration, creation, enhancement and preservation. *The London Plan* (1402) touches on offsetting or "compensatory mitigation"**,** stating that it may be provided through "additional rehabilitation and/or remediation beyond the area directly affected by the proposed works" and/or "off-site works to restore, replace or enhance the ecological functions affected by the proposed works". **Should London choose to embrace offsetting over preservation to reach its stated goals of enhancing wetland area, the City will have to address key issues: the appropriate policy mechanisms for implementation; the roles and responsibilities for implementation; long-term monitoring of wetland offsetting and restoration projects; and the establishment of clear monitoring to ensure that the wetlands' functions have been properly restored (Ontario Ministry of Natural Resources and Forestry, 2017). In addition, should offsets or relocation be the chosen course of action, the impacted biodiversity values must be clearly defined and measured; time lags and uncertainties must be explicitly accounted for in loss/gain calculations; and any time lags should not pose an interim threat to biodiversity values.**

## 2. Primary Screening When a Project Will Potentially Affect a Wetland: Determining the best course of action

In Ontario, wetlands are ranked to determine whether they should receive special protection as "provincially significant" in accordance with the Ontario Wetland Evaluation System (OWES) . This system is found at: **https://www.ontario.ca/page/wetlands-evaluation**. Provincially Significant Wetlands (PSWs) are those areas identified by the province as being the most valuable. PSWs are identified using objective criteria based on the best available scientific methods. The OWES ranking system is a standardized method of assessing wetland functions and societal values, which enables the province to rank wetlands relative to one another. A wetland that has been evaluated using the criteria outlined in the OWES is known as an "evaluated wetland" and will have a "wetland evaluation file". As wetlands may change over time an OWES file for a given wetland is considered an "open file".

Small wetlands that have not been previously evaluated are often affected by development projects. It is therefore vital to perform a comprehensive evaluation prior to taking the decision to disturb and/or relocate the wetland. Assessment of the wetlands will consist of quantitative and qualitative observation. **Quantitative observations** should include amphibian call surveys (three spring visits); crayfish burrow count using the quadrat method; baited minnow trapping; riparian and aquatic vegetation inventory; and the measuring of spring, summer and fall water levels. **Qualitative observations** may include a benthic organism survey (biomapping), water pH analysis, specific conductivity (dissolved solids), turbidity (suspended solids), water colour (algae), and an examination of the presence and levels of chlorides and nitrites. Other qualitative observations should consist of a search for the presence of turtles and any incidental wildlife; a determination of whether backyard encroachment exists; and an analysis of the health of neighbouring woodlots and other vegetation (invasive species) near and beyond the wetland. Presence of an invasive species in a wetland should not be justification for the removal or relocation of the wetland. Options to remove the invasive species and restore the wetland should be equally considered.

The following checklist will assist in determining whether small isolated wetlands should be preserved. It should be kept in mind when examining this list that concluding whether or not a wetland should be protected is largely subjective. Each wetland is unique, with particular functions and traits that account for its regional importance. Therefore, it is not possible to state that if a wetland possesses a certain number of the following qualities, it should be preserved; each point needs to be evaluated for its own merit.

| IF | YES | NO |
|---|---|---|
| The wetland has a groundwater connection to a larger complex (i.e. PSW) | | |
| The wetland is supported by groundwater discharge (re: specific wetland plants presence) | | |
| The wetland is part of a floodplain | | |
| A watercourse connects the wetland to other aquatic features | | |
| The wetland serves as storm water storage | | |
| The wetland is habitat for breeding amphibians | | |
| The wetland sits close to a woodland and Western Chorus frogs were heard calling | | |

| | | |
|---|---|---|
| The wetland was recently (within the last 20 years) a fish habitat | | |
| The wetland was recently (within the last 20 years) a turtle nesting habitat | | |
| The wetland was recently (within the last 20 years) habitat for seasonal Concentration Areas (i.e. migrating birds) | | |
| Terrestrial crayfish chimneys were observed surrounding the wetland | | |
| Barn Swallows were observed foraging in the area | | |
| SAR species (threatened or endangered) were found | | |
| The wetland serves a corridor function linking neighbouring natural heritage features together | | |

## 3. Next Steps: How Best to Ensure Success With a Wetland Offset

If the decision is taken to relocate a wetland as a means to compensate for damage, disturbance or removal of a wetland entirely to satisfy a development project, the stakeholders must consider ten key aspects prior to the work. Ducks Unlimited outlined five considerations in their publication "Wetlands on My Lands" (2011): site selection; soil testing; size and shape; wetland depth; and wetland and upland enhancements. While this publication is meant to address wetlands on private properties, the principles are relevant for city projects that involve small wetland areas. This list has been expanded to cover other key aspects associated with potentially successful wetland transfer. Some policy statements require offsets to be in place before a project takes place. Though this provision may be advisable with the pace of development in London, it may not be practicable.

Offsets are never one-size-fits all; local contexts can provide a variety of challenges, and relocation or re-creation cannot produce an exactly equivalent wetland. The City and developers must then determine how to best create "equivalency" to address the losses of biodiversity and functionality. In particular, prior to any relocation or offset project, the City must ascertain where the offset should be located, when and for how long it should be operational, how risk of failure will be managed, and what will be the next course of action should an offset fail to reach its goals (McKenney and Kiesecker, 2010). After gathering sufficient data, wetland performance model should be developed prior to commencing re-creation or relocation projects (Charbonneau and Bradford 2016). This section of the report will provide basic guidelines for wetland relocation should a wetland fall within the boundary of a development project. It is essential to remember when reading these guidelines that scientific evidence supporting successful relocation or re-creation projects is limited; avoiding disturbance is prefered.

**1. Site Selection** - Site selection usually is determined based on the availability of land or on policies that require the restored or created wetland to be in close proximity of a wetland loss (usually due to migration considerations). Location is extremely important in terms of influencing the structure and function of the wetland and guaranteeing its longevity. Planners must consider both present and future land uses. Ducks Unlimited suggests that the site for the new wetland be determined during spring runoff to better understand water flows, and to calculate a more accurate estimate of the catchment area. A topographic survey is recommended to provide more accurate data about surface flow. Should the survey determine that the site has less than 0.6 m drop, then excavating a basin is required. The new wetland should be located near a significant woodland or other natural features (i.e. stream) such that it is not isolated and can be an integral part of the natural landscape. Studies show that larger wetlands recover faster than smaller ones, and that smaller restored or created wetlands often become more isolated. Moreover, their lack of connectivity to larger systems greatly hinders the ability of local biota to restore the wetland to pre-impact functioning (Moreno-Mateos et al., 2012). This finding is significant for London where development projects will likely only involve smaller wetlands within a highly fragmented landscape.

Site selection is tied to hydrologic analysis. The hydrologic conditions are probably the most important factor for determining what type of wetland can be established and what kind of wetland processes can be maintained (Kentula, 2002). These include inflows and outflows of groundwater and surface water, the resulting water levels and the timing and duration of soil saturation and flooding (Kentula, 2002). The water quality of the wetland is highly important, yet often overlooked. If there are chemical inputs from the surrounding area, these can overwhelm a wetland. This is particularly important if the wetland is close to a road spread with de-icing salts. Chemicals can alter the productivity and composition of the plant community of the wetland, possibly favouring nuisance species, and they may harm animal species that cannot survive and breed in chemically altered waters.

**2. Test the Soil** - Wetlands are characterized by Impermeable soils. Fine-textured soils -- not sandy or gravelly -- are suitable. Should the soil for the new site not prove suitable, clay soils can be brought in to line the basin so that the wetland can hold water.The soils of a wetland are equally important. Although a created wetland may be structurally similar to a natural wetland, its hydrology may differ greatly if the permeability of the substrates is different (Kentula, 2002). Often the soils in created wetland contain less organic matter, which may affect plant growth. Using soils from a "donor" wetland or the impacted wetland to help create the new wetland may be able to increase the soil organic matter and provide the nutrients necessary for plant species, microbes and invertebrates (Kentula, 2002). Created wetlands will do better if the plants chosen closely to resemble those of similar, local wetlands.

Microbes in the wetland play a crucial role in biogeochemical reactions which cause nutrient cycling and sustain other higher plants and animals. Comprehensive understanding of microbial composition and population will facilitate better understanding about a wetland condition (Bodelier and Dedysh, 2013).

**3. Size and Shape** - If the recreated wetland is to replace a previously existing wetland as an offset, the new wetland should cover an area three times that of the original to best guarantee success and to compensate for the inevitable loss in functionality. Ducks Unlimited suggests that the new wetland be irregularly shaped such that it closely resembles a natural wetland (as opposed to a storm pond), providing coves to shelter species.

*Multiplier ratios.* To address the problem that restoration or re-creation projects rarely, if ever, produce an equally biodiverse and functional wetland, multipliers are employed to determine the scope of an offset project. Since wetlands are particularly valuable, the offset multiplier for wetlands is usually higher compared to other areas. *The London Plan* specifies that "mitigation shall mean the replacement of the natural heritage feature removed or disturbed on a one-for-one land area basis" (*The London Plan,* 1401), which is not sufficient given the uncertainties of success and the goal of the provincial wetland strategy of creating a net gain in wetland area. However, *The London Plan* goes on to say "compensatory mitigation shall mean additional measures required to address impacts on the functions of the Natural Heritage System affected by the proposed works. The extent of the compensation required shall be identified in the environmental impact study, and shall be relative to both the degree of the proposed disturbance, and the component(s) of the Natural Heritage System removed and/or disturbed" (*The London Plan,* 1401). 1402 (3) likewise states that "[replacement ratios greater than the one-for-one land area [are] required to mitigate the impacts of the proposed works" (*The London Plan*, 1402). Given the extent of wetland loss in London and the high ecological value they provide the suggested multiplier ratio would be 3:1 for the loss or disturbance to a low to medium value wetland; and 4:1 for a high value wetland, particularly one that provided habitat for SAR species.

**4. Wetland Depth** - Developers should excavate the floor of the new wetland such that it has varying depths to encourage the growth of various types of vegetation. New vegetation will grow in water depths of 1 metre or less. To achieve the ideal ratio of vegetation and open water, Ducks Unlimited advises that approximately 25 percent of the created wetland area be 1 m or more in depth. Excavating some deeper areas will allow some areas to remain free of vegetation and provide habitat for native fish.

**5. Wetland and Upland Enhancements** - The newly established wetland should be surrounded by a buffer of grasses, trees and shrubs. Developers should install nest boxes to encourage cavity nesting birds to inhabit the site. Strategically placing branches or logs in and around the wetland would likewise provide basking areas for frogs, turtles and ducklings.

**6. Substrate augmentation and handling -** In an interview with Jill Crosthwaite, a biologist with the Nature Conservancy of Canada, she emphasized the importance of transferring muck (the organic salvaged marsh surface or SMS) from the impacted wetland to the new wetland. The SMS contains a seed bank of marsh vegetation that could prove immensely beneficial to establishing a healthy and ecologically diverse wetland. Following the transfer of SMS from the original wetland to a new location, Crosthwaite has witnessed the re-emergence of an endangered species in the created wetland that was absent from the impacted one.

Hunt (1996) likewise analyzed the effects of on-site and off-site SMS transfer and found that SMS provides suitable chemical substrate for wetland seed germination and survival, as well as moist physical substrate. However, the plant composition of the created wetland may never fully resemble that of the original, natural wetland due to large difference in soil water chemistry. Based on the results of that study, two 'common sense' practices should be considered. First, the excavated soil from the new wetland should not be spread over the perimeter soil area. This soil should be removed from the site as it may alter the chemistry of the transferred wetland soil. Second, the excavation equipment employed during the project should be small and lightweight and should avoid as much of the perimeter area as possible; a narrow alleyway to the excavation area will help prevent significant soil compaction.

Finally, a study by Wolf et al. (date), found that nutrient nitrogen and phosphorus levels varied depending on whether the natural or created wetland was dependant on a stream as its primary water source, or whether precipitation or groundwater fulfilled this function. Greater connectivity to stream surface water may result in larger inputs of allochthonous nutrients (sediments or rocks originating at a distance from their present position) that could stimulate internal nitrogen and phosphorus cycling. The findings suggested that wetland creation and restoration projects should be designed to allow connectivity with stream water if the goal is to optimize the function of water quality improvement in a watershed.

**7. Planter material selection and handling -** Plants for the re-created wetland should be native, fast colonizing and drought resistant to account for fluctuations in weather and climate. Where possible, plants should be transferred from the original wetland to the new location. A variety of submergent and emergent plants should be planted, including a variety of shrubs and trees in the buffer areas to provide habitat for species as well as to ensure that water quality in the wetland is maintained. In the early years, the wetland must be closely monitored to ensure that invasive species are not permitted to colonize the area, particularly *Phragmites*.

**8. Buffer zone placement** - Buffers -- undisturbed vegetation adjacent to a wetland -- are essential to ensure a healthy wetland (Ducks Unlimited Canada (B)). Buffers provide habitat, food, corridors and breeding areas for species while also reducing the harmful effects of nearby development or activities and maintaining water quality by trapping and absorbing sediments, nutrients and pollutants. According to Ducks Unlimited Canada, buffers should be a minimum of 20 metres but the larger the buffer the better the results. A buffer of 20-50 metres will decrease sedimentation and improve water quality, while a buffer that extends beyond 50 metres is best for wildlife and water quality (Ducks Unlimited Canada (B)). The minimum buffer width will depend on the size of the wetland , the purpose of the buffer, the land use of the surround area, the soil type (less permeable soil will require larger buffers) and slope (Ducks Unlimited Canada (B)). For instance, a smaller, deeper, excavated wetland with minimal wildlife or hydrological value could require a buffer of only ten metres, while a wetland where the slope of the land is greater than 5 percent would require a buffer greater than 20 metres (Ducks Unlimited Canada, (B)). All these factors should be considered together when determining the buffer size. The buffer should consist of diverse, multi-layered vegetation, incorporating trees and shrubs. In all instances of created wetlands and their associated buffers, the vegetated buffer areas must be managed and maintained over the long-term to ensure that they are providing the maximum benefit to the wetland (Ducks Unlimited Canada (B)).

**9. Species transfer -** Ideally species transfer should not occur until a year has passed since the creation of the new wetland to allow the environment to settle and to ensure that the water quality and nutrients can safely support wildlife, much like when one is preparing a new tank to house fish. Monitoring of the site should confirm ideal conditions before any species transfers take place. If monitoring indicates that certain populations are in decline, additional individuals can be transferred into the compensation wetland (e.g. import tadpoles or broadcast more native seeds). Species transfer should not occur during a single day or even week, but should be carried out over an extended period of time and slowly to ensure minimal negative impact and to increase the possibility of capturing more individuals from the original wetland site. Timing of the transfer is likewise very important. The breeding time of certain species (i.e. the Western Chorus frog) as well as the schedules of burrowing animals (i.e. crayfish) must be accounted for throughout the process.

Options for manual transfer for species include baited minnow trapping, dip netting, seine netting and hand picking. Once the individuals are captured, they are transferred to the new wetland in buckets. If insufficient resources are available to do manual transfers of species, other options are possible. For instance, if the new wetland site is sufficiently close to the old one, a trench could be dug from one site to the other to allow species to transfer naturally. Alternatively, the new wetland location could be situated near a stream or other water source to allow species to populate the created wetland on their own.

**10. Long-term management and monitoring** - Ontario is still in the process of determining an acceptable duration for wetland offsets and whether monitoring should remain only until negative impacts have been resolved or should continue in perpetuity. Given the ongoing losses of wetlands across southern Ontario, it is strongly advisable that wetland restoration, relocation and creation projects for the purposes of offsetting should continue in perpetuity. This recommendation is critical given the lack of proof that such altered and/or created wetlands recover full functionality, and given the long lags associated with wetlands' maturation. Moreover, it is imperative that once a wetland has been moved for one project, that "relocated" or offset wetland should not then itself become subject of another development project and be relocated again.

Before the monitoring process even begins, practitioners, developers, and the City must clearly define what a "successful" relocation or restoration would entail for each *individual* project and outline a clear set of objectives. For instance, even if a site has revegetated, it could be functionally inadequate, and/or the plant composition may differ from the initial goals. Next, the City must establish which methods it plans to employ (or request that developers employ) to determine the success of wildlife transfer and establishment. Options include quadrat studies (for species like crayfish) and the capture-mark-recapture method (Pradel, 1996).

Currently, three, five, ten-year monitoring reports are typically required, with qualitative and quantitative observations of water level, riparian and aquatic vegetation, overflow, breeding birds, amphibians, terrestrial crayfish chimneys and incidental wildlife associated with the constructed feature. However, given the significant time lags associated with wetland re-creation and/or restoration projects this time scale is inadequate. Careful and regular monitoring over a long period of time is vital to catch any problems that may arise (wetland shrinkage, incursion by invasive species). Adaptive management of the created wetland will be crucial to ensure a greater probability of success since this genre of projects is relatively new and the science behind the workings of a healthy, functioning, high value wetland is complicated.

Finally, before a developer or the City embarks on a project, every effort should be made to ensure that sufficient funds are budgeted to carry out long-term monitoring of wetland relocation projects or projects which adversely impact a wetland. In the case of London's first wetland relocation project at 905 Sarnia Road (see Appendix 2), resources for monitoring allowed for only two years of study past the project date. This time span is inadequate to determine whether the project resulted in no-net-loss of wetland cover and/or biodiversity. Going forward, approval of wetland relocation projects should be contingent on developers demonstrating the availability of funds commensurate with carrying out robust monitoring programs over a minimum of three, but preferably ten, years.

## 4. Conclusion

The field of restoration ecology is relatively new and consequently, the scientific evidence supporting the merits of wetland relocation is lacking, largely due to insufficient data collection and monitoring following relocation, re-creation or restoration projects. If London chooses to embrace a wetland offsetting policy in line with Ontario's policies, it should look to the lessons learned from other jurisdictions, which have highlighted four key considerations (Poulton, 2017):

First, the need for reliable tracking, reporting and record keeping is paramount. Baseline data on wetland functions lost to development must be recorded, and the City must require long-term monitoring to ensure that wetland functions are restored.

Second, the City should adopt a watershed-based approach. Rather than looking at each individual development application and the resulting decision to offset in a piecemeal approach, decisions should be based on an assessment of the wetland needs in the watershed and the potential for the compensatory wetland to persist over time. The individual offset site should be designed to maximize the likelihood that they will make an ongoing ecological contribution to the watershed.

Third, and perhaps more importantly, the City must make every effort to adhere to the mitigation sequence. Priority should be given to avoidance and minimization of adverse impacts. By skipping directly to the compensation step, opportunities to preserve natural heritage will be lost.

Fourth, the City must ensure compliance through inspection, monitoring and enforcement before and after project construction. The monitoring reports arising from London's first wetland relocation project involving species transfer (see Appendix 2) demonstrate the need for improvement in monitoring of wetlands post disturbance or post relocation. Evaluation of the status of the wetlands and the species inhabiting the area should be thorough, with concrete numbers of species to the best of the evaluators ability, and, due to the complexity of wetland systems, should include qualitative analysis of the area to determine its overall health and future viability. Going forward, the City is advised clearly lay out the monitoring requirements on projects affecting wetlands, and set a precedent of enforcing those regulations to better guarantee no-net-loss of London's wetland cover.

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## Appendix 1. Discussion Paper Recommendations

a. The precautionary principle should influence all projects involving wetlands.

b. When wetlands are involved in an infrastructure project, the priority should always be to avoid impacts to the maximum extent possible.

c. Any wetland conservation strategy should integrate climate change adaptation and mitigation into its policies and outlook.

d. Compensatory mitigation should not be used to make a potentially avoidable project seem more acceptable.

e. Economic priorities should not outweigh ecological considerations in regards to new development projects.

f. Restoration and re-creation of wetlands should be designed to both technically and legally last in perpetuity.

g. A wetland which has been restored or relocated in compensation for another project should not subject to removal or further threats because of its “unnatural” status. It cannot be used as an excuse for future disturbance.

h. All restored and relocated and disturbed wetlands must be monitored for more than 10 years.

i. Adaptive management must be incorporated into all wetland restoration and relocation projects, including removal of invasive species and other necessary actions to achieve desired outcome.

j. Buffer zones are very important especially in urban areas. There should be undeveloped, vegetated land around wetlands and/or a fence or barrier. The composition and width of the buffer depends on the land use that is occurring adjacent to the created wetland, and also the requirements of the animals that will use the wetland and the buffer area.

k. The guidelines should apply to ephemeral water bodies (i.e. those present in spring and early summer). Such bodies are present in many areas of London and play a significant role in the maintenance of life systems in green areas.

## Appendix 2. London's First Monitored Wetland Relocation

The City of London has already endeavoured to relocate and establish a viable wetland as the result of a construction project. As the first attempt at a project of this magnitude, this case study provides, and will continue to provide, valuable knowledge regarding the feasibility of successfully re-creating a wetland, and appropriateness of employing an offsetting policy to balance development with conservation. This relocation project is located at 905 Sarnia Road in the Hyde Park Community, where a subdivision now sits on an 8.2 hectare parcel of land. The subject land is bordered by the CP railway to the south, a significant woodlot to the northwest and a newly developed suburb to the north and northeast.

Before construction took place, two small wetland features (measuring 0.15ha and 0.13ha), neither of which were considered Significant Wildlife Habitat, were located within the northeast corner of the property. Due to evidence of amphibian breeding and the presence of terrestrial crayfish, the City requested that the developer compensate for the loss of the south pond. The wetland compensation plan included: the creation of similar habitat elsewhere on the subject lands; the creation of a pond and riparian area within and adjacent to the woodland buffer located at the western property limit; the transfer of target wildlife (breeding amphibians and terrestrial crayfish) to the new pond; and the implementation of a two-year annual post-construction monitoring and adaptive management plan. A site was chosen near a significant woodland for the creation of a new wetland.

**Target Species.** The reason behind these extraordinary steps taken to relocate this particular wetland lay in the abundant target species found on the Sarnia Road site, specifically Calico Crayfish (*Orconetes immunis*). The high number of crayfish was unexpected. Western Chorus Frog ( *Pseudacris triseriata*) was the other significant target species, though only a few frogs were heard in the north pond of the wetland.

*Calico Crayfish:* Calico crayfish are found in stagnant ponds and ditches and slow-moving streams, where the bottom is mud with a heavy growth of rooted aquatic vascular plants. Because this species can burrow one metre deep in the ground when necessary, it utilizes temporary pond habitat and spends the winter in the burrows. This species is largely herbivorous, feeding on the abundant vegetation of a pond, or, at night, on terrestrial plants close to shore. They are active both by day and night, but the adults are more strictly nocturnal. The species can travel across dry land at night, especially in the presence of rain or a heavy dew, and in this way they can move from pond to pond. Copulation takes place from mid-July to early October, with mostly yearling individuals participating. Eggs are laid in late October, and are carried on the underside of their abdomen through the winter. Juveniles spend the summer growing, may become sexually active in September, though most individuals delay breeding until late the following summer. The normal lifespan is two years (Crocker, 1968).

*Western Chorus Frog:* Western Chorus Frogs weigh as much as a paperclip and measure no longer than three centimetres. They feed on small insects and other invertebrates. During breeding, western chorus frogs use shallow, fishless ponds and large puddles that dry up in the summer. Reproduction happens just after ice-out in early spring. Eggs hatch and tadpoles grow into adults in as little as two months depending on the water temperature. After breeding, the adults move overland (they require 25 days to travel 200 metres) to protected areas (woodlands) where they remain active the rest of the summer and spend the winter in undisturbed soft soil. Special proteins protect their cells from damage due to freezing. Most individuals live no longer than one year, though some have a lifespan of two to three years. Meadows and forests located right next to breeding ponds provide great habitat where frogs can spend the summer and overwinter undisturbed (Bird Studies Canada pamphlet).

**Relocation Process.** During the wetland relocation, a number of steps were taken over several months to transfer wildlife from the existing wetland to the new site. In November 2015 construction began for the new compensation pond. On May 18, 2016 the developers graded the new habitat features and added root wads to the new feature banks. Native seeds were dispersed in the deep pool, shallow pool, riparian areas and dry upland areas surrounding the feature.

From July 7 to 13, 2016, the developers began the process of dewatering the old pond and transferring water to the new location. The wildlife transfer also began with seven days of baited minnow trapping. On July 13, dip netting, seine netting and hand picking techniques were employed to capture wildlife at the original site. These species were placed in tall buckets and transported to the compensation pond. Benthic populations were likewise transferred to the compensation wetland. At the same time, selective transfer of riparian vegetation from the existing to the compensation pond occurred. Riparian topsoil was not transferred due to the possible presence of invasive seed banks. Downed woody debris was collected from around the existing wetland and placed strategically around the compensation area to provide basking opportunities for wildlife transfers. Finally, additional muck was transferred to the compensation pond.

**Results of the Relocation Process.** During the transfer process, trapping, netting and hand-picking resulted in the capture of approximately 63,874 wildlife individuals. The capture species included: Calico crayfish (18166), Green Frog(4869), Northern Leopard Frog (1450), Brook Stickleback (11522), Eastern Newt (21), Midland Painted Turtle (10), Snapping Turtle (3), and other invertebrates (28803). It was determined that eighty percent of the total wildlife population was successful relocated.

**Post-Transfer Survey.** On October 7, 2016 an assessment of the new wetland was conducted. When the wetland was surveyed in July, water was restricted to the deeper (western) portion of the pond. By October, water levels had increased noticeably and the shallow (eastern) portion of the wetland was also inundated. No outflow to the surrounding woodland was observed. The banks of the compensation wetland had re-vegetated naturally, including grasses, forbs and shrubs, to or just above the high water mark. Vegetation coverage was estimated at 70%, and appeared sufficient to mitigate shoreline erosion.

**Comparison of Data Collected at 905 Sarnia Road**

As part of the transfer process, the relocated wetland has been monitored over a period of two years -- 2017 and 2018. The table below compares the findings over the monitoring period, offering a brief look at the viability of the created wetland. At the surface, the numbers suggest that in regard to the target species, particularly the crayfish, which were the most affected by the project through active displacement, the transfer has seen some positive results. However, it is unclear how Stantec or the City would determine whether the transfer has achieved its stated goals, and whether the project resulted in no-net-loss of wetland habitat. Several gaps are present in the monitoring reports that raise some questions.

The monitoring reports lack specificity in some areas and as such, drawing conclusions on the success of species to colonize the areas is not possible. For instance, the 2017 Monitoring Report stated that “multiple” crayfish chimneys were observed. Without a clear number, future analysts cannot determine whether the “approximately” 25 chimneys observed in 2018 is more or less than in 2017. It would be advisable that going forward with future wetland transfer projects, monitoring reports should contain more concrete data from which comparisons can be drawn. Without that data, it is impossible to determine whether or not the project has achieved No-Net-Loss of wetlands and/or biodiversity.

Another observation is that a bird survey was not carried out in 2018. This omission seems to suggest that the consulting firm was almost exclusively interested in the status of the translocated species and not in the overall ecosystem health and viability of the new wetland. Even if the presence of birds is not directly related to the manual transfer of target species, it is a means by which to determine the overall species richness of the area and its potential to thrive in the future and to act as an integral component of the natural heritage system. In the future, the requirements for monitoring should stipulate more qualitative assessments of the area that go beyond simple target species counts. Wetlands are intricate and complicated systems and therefore the indices for determining their health, particularly in the case of created wetlands, must be more nuanced. When transferring a wetland, it is not simply about relocating species, it is about establishing a viable wetland.

Furthermore, it is crucial to analyze potential threats to the wetland, particularly in regard to human activity. When wetlands are isolated (i.e. surrounded by development), human activity can have significant, often negative, impacts. Since, the early years of the newly created wetland are critical to its long-term success, threats should be both noted and remediated. For example, studies should assess the state of the buffer surrounding the wetland to determine whether its size is sufficient for protecting the area as well as to determine whether the buffer itself is thriving. The buffer at 905 Sarnia road shows evidence of having been mowed and a fire pit is located within the buffer. These issues were absent from the 2018 report. Light and noise pollution could equally affect the viability of the wetland to provide adequate habitat for target species. Light pollution is also of significant concern at the new wetland location. This issue should be noted and efforts should be taken to alert residents to the negative effects excessive light can play in animal health and behaviour.

Funds and resources for monitoring the success of the relocated wetland are no longer available; consequently, future study into the outcomes of the wetland transfer project cannot continue. The shortfall in funding is unfortunate given the complexity of creating a new wetland and given that this project is the City's first venture into this area of restoration ecology. As the flagship relocation project in London, 905 Sarnia has the potential to serve as a learning tool to determine best practices and where improvements could be made in the future to best guarantee a successful wetland transfer. A two-year study is simply inadequate to ascertain whether a project has achieved no-net-loss of wetland area. Analyzing the plant data alone demonstrates a net-loss of biodiversity two years following the relocation project. Therefore, every effort should be made to budget more funds for monitoring future relocated wetlands. If public funds are not available, the City may wish to consider private sources of funding or funding through other organizations, such as Conservation Authorities, or environmental non-governmental organizations.

| Wetland Components Surveyed | EIS 2014 (Original Wetlands) | Monitoring Report 2017 (Relocated wetland) | Monitoring Report 2018 (Relocated Wetland) |
|---|---|---|---|
| Amphibian survey | North pond:<br>April - (1-1) Chorus Frogs<br>(3) Spring Peepers<br>May - no calls<br>June - no calls<br>South pond<br>April - (3) Spring Peepers<br>May - (1-5) Gray Treefrogs<br>June - (1-2) Green frogs<br>(1-3) Gray Treefrogs<br><br>Leopard frog observed | April - (3) Spring Peepers<br>May - (1-2) Spring Peepers<br>June - (1-1) Green Frogs<br>(1-3) Gray Treefrogs<br>(calling in pond)<br>(3) Gray Treefrogs<br>(calling in adjacent woods)<br><br>Green Frog Tadpoles observed | April (3) Spring Peepers<br>(from woods)<br>( 1-1) Spring Peeper<br>(from pond)<br>May - (2-5) Gray Treefrogs<br>(calling in pond)<br>(3) Gray Treefrogs<br>(calling in pond & wood)<br>Observed adult Leopard and Green Frogs<br>Observed Green Frog tadpoles |
| Terrestrial Crayfish Chimneys | Stantec observed crayfish around north pond. Not counted<br>City Staff observed around south pond. Not counted | Multiple chimneys observed | Approximately 25 chimneys observed |
| Vascular Plants | 67 species observed in wetland and surrounding cultural thicket<br>81% native plants | 45 species observed<br>60% native plants | 57 species observed<br>61% native plants |
| Turtles | None observed | 2 midland turtles observed | 1 midland turtle and<br>1 snapping turtle observed |
| Fish | North pond – not suitable for fish<br>South pond – marginal fish habitat | Brook Stickleback observed | Brook Stickleback observed |
| Birds | 12 species including Barn Swallows observed | 32 species including Barn Swallow and Eastern Wood-Pewee observed | Bird Survey not completed.<br>Barn Swallow Kiosk not being used. |
| Snakes | None observed | None observed | None observed |

| | | | |
|---|---|---|---|
| Incidental Wildlife | Northern Racoon , Groundhog and Eastern Cottontail observed | Raccoon tracks, White-tailed deer tracks, Great Blue Heron, Canada Goose, Eastern Cottontail scat, Garter snake, Cooper's Hawk, Northern Flicker, White-breasted Nuthatch, Blue Jay, Turkey Vulture, Wild Turkey | Raccoon tracks, White-tailed deer tracks, Cooper's Hawk, White-breasted Nuthatch, Blue Jay, Turkey Vulture, Wild Turkey, Northern Flicker, Eastern Wood-Pewee, Great Horned Owl (breeding) |
| Odonata | Not Reported | 7 species | Not Reported |
| Butterflies | Not Reported | 7 species | Not Reported |
| Water Level | Not Applicable | April – very high (to the point of overflowing)<br>October – levels decreased, but remained high in the deeper portion | May - very high, pond full<br><br>July - Wetted Edge consisted of two-thirds of pond circumference. |

**Analysis of 905 Sarnia Road Wetland Relocation Project.** Following the completion of the wetland transfer project, a Working Group of the Environmental and Ecological Planning Advisory Committee (EEPAC) of the City of London has created four recommendations for future projects of this nature to minimize biodiversity loss and damage to the surrounding ecosystem.

**Recommendation #1: The Wetland Compensation Plan should state an achievable set of goals that serve as an indicator of a successful relocation.** Each relocation project must contain concrete objectives. The simple act of recreating a wetland is not sufficient; with compensatory mitigation, tangible improvements to ecological features and functions must be realized and documented. A 'net loss' of the targeted habitat is to be avoided.

**Recommendation #2: Measurable performance standards (baseline data) should be established, along with a detailed method for tracking, reporting and recordkeeping.** A sampling of species must be conducted before any relocation is permitted. The totals collected (by species) must be recorded. A report should be prepared which includes minimum requirements for the repopulation of the various species with emphasis on 'target' or indicator species as agreed to by a City Ecologist. The requirements should include species at risk, terrestrial crayfish, birds (if relocation is adjacent to a Significant Woodland), amphibians and herps.

**Recommendation #3: Wildlife salvage and transfer to the compensation pond should only occur once the pond becomes a functioning supportive habitat. A twelve-month delay between pond construction and wildlife transfer would enhance wildlife survival.** City staff must determine the suitable time frame between the construction of the compensation pond and the transfer of wildlife. This aspect of wetland relocation is significant since sufficient organic matter must accumulate in the pond bottom and emergent and submergent plants must have adequate time to become established to ensure a viable habitat for introduced fauna.

**Recommendation #4: The proponent will conduct an assessment, followed by monitoring enforcement, remedial measures and reporting for a minimum of five years.** Careful and regular monitoring over an extended period of time is vital to uncover problems that may arise, and to ensure greater probability for success.

## Appendix 3. Legal Requirements to Protect Wetlands

**1. Ramsar (1971)**

**Article 3(1).** The Contracting Parties shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory.

**2. Convention on Biological Diversity (1992)**

**Article 6(b)**. Each Contracting Party shall, in accordance with its particular conditions and capabilities integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.
Article 8(d). Each Contracting Party shall, as far as possible and as appropriate promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings.
**Article 8(e)**. Each Contracting Party shall, as far as possible and as appropriate promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas.
**Article 8(f)**. Each Contracting Party shall, as far as possible and as appropriate, rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of plans or other management strategies.
**Article 8(h)**. Each Contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.

**3. Provincial Policy Statement (2014)**

**2.1.2.** The diversity and connectivity of natural features in an area, and the long-term ecological function and biodiversity of natural heritage systems, should be maintained, restored or, where possible, improved, recognizing linkages between and among natural heritage features and areas, surface water features and ground water features.

**2.1.4** Development and site alteration shall not be permitted in: a) significant wetlands in Ecoregions 5E, 6E and 7E.

**2.1.6.** Development and site alteration shall not be permitted in fish habitat except in accordance with provincial and federal requirements.

**2.1.7.** Development and site alteration shall not be permitted in habitat of endangered species and threatened species, except in accordance with provincial and federal requirements.

**2.2.2.** Development and site alteration shall be restricted in or near sensitive surface water features and sensitive ground water features such that these features and their related hydrologic functions will be protected, improved or restored. Mitigative measures and/or alternative development approaches may be required in order to protect, improve or restore sensitive surface water features, sensitive ground water features, and their hydrologic functions.

**4. The London Plan (2016)**

**1308.** We will plan for our city to ensure that London's Natural Heritage System is protected, conserved, enhanced, and managed for present and for future generations by [...] (3) protecting, maintaining, and improving surface and groundwater quality and quantity by protecting wetlands, groundwater recharge areas and headwater streams.

**1332.** Development and site alteration shall not be permitted in provincially significant wetlands as identified on Map 5 or determined through environmental studies consistent with the Provincial Policy

Statement and in conformity with this Plan. Wetlands evaluated using the Ontario Wetland Evaluation System are classified on the basis of scores determined through the evaluation. Wetlands meeting the criteria set forth by the Ministry of Natural Resources and Forestry shall be confirmed by the Ministry of Natural Resources and Forestry, and shall be mapped as provincially significant wetlands on Map 5 and included in the Green Space Place Type on Map 1. Wetlands can be identified using Ecological Land Classification. Where a wetland is identified through Ecological Land Classification, the significance of the wetland must be evaluated using the Ontario Wetland Evaluation System.

**1333.** For wetlands that are evaluated using the Ontario Wetland Evaluation System and confirmed by the Ministry of Natural Resources and Forestry to not be provincially significant, the City of London shall identify the wetland on Map 5 as wetland and include it in the Green Space Place Type on Map 1.

**1334.** Development or site alteration shall not be permitted within a wetland. There shall be no net loss of the wetland features or functions. In some instances, and in consultation with the conservation authority having jurisdiction, the City may consider the replacement of wetlands where the features and functions of the wetland may be provided elsewhere and would enhance or restore the Natural Heritage System.

**1335.** Development and site alteration shall not be permitted within and/or adjacent to an unevaluated wetland identified on Map 5 and/ or if an Ecological Land Classification determines that a vegetation community is a wetland that has not been evaluated. City Council shall require that the unevaluated wetlands be evaluated by qualified persons in accordance with the Ontario Wetlands Evaluation System. The evaluation must be approved by the Ministry of Natural Resources and Forestry. Map 1 - Place Types and Map 5 - Natural Heritage shall be amended as required to reflect the results of the evaluation.

**1390.** Development and site alteration shall not be permitted within a provincially significant wetland.

**1391.** Development and site alteration shall not be permitted in significant woodlands, significant valleylands, significant wildlife habitat, wetlands, and significant areas of natural and scientific interest unless it has been demonstrated that there will be no negative impacts on the natural heritage features or their ecological functions.

**1392.** Development and site alteration shall not be permitted in fish habitat and in habitat of endangered species and threatened species, except in accordance with federal and provincial requirements.

**1401.** For the purposes of this Plan, mitigation shall mean the replacement of the natural heritage feature removed or disturbed on a one-for-one land area basis. Compensatory mitigation shall mean additional measures required to address impacts on the functions of the Natural Heritage System affected by the proposed works. The extent of the compensation required shall be identified in the environmental impact study, and shall be relative to both the degree of the proposed disturbance, and the component(s) of the Natural Heritage System removed and/or disturbed.

**1402.** Compensatory mitigation may be provided in forms such as, but not limited to: 1. Additional rehabilitation and/or remediation beyond the area directly affected by the proposed works. 2. Off-site works to restore, replace or enhance the ecological functions affected by the proposed works. 3. Replacement ratios greater than the one-for-one land area required to mitigate the impacts of the proposed works.

**1405.** The City shall develop a program for the long-term acquisition of natural heritage areas. Acquisition may occur as properties become available primarily through the following methods: purchase; dedication; and donation or bequest.