A Call for Action to Protect Vernal Ponds in Ontario

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INTRODUCTION

Vernal ponds are broadly defined as ephemeral wetlands that predictably form in permanent basins during the cooler part of the year. They are considered to be vernal since they dry up during the summer months. According to Zedler (2003) they are particularly abundant on the Pacific Coast and in various forms in the glaciated landscapes of the north and northeast of the United States. In Ontario, they are generally situated in shallow depressions within forested terrain (Rheinhardt and Hollands 2007). Vernal ponds serve an important local biodiversity function due to their situation within surrounding terrestrial habitats. As with other wetlands in Ontario, vernal ponds are threatened by numerous anthropogenic stressors (Mahaney and Klemens 2008).

An important and often undervalued class of wetlands, vernal ponds (also called vernal pools) are one of many types of geographically isolated wetlands which are defined by Tiner (2003, p. 495) as "hydrophytic plant communities surrounded by terrestrial plant communities or undrained hydric soils surrounded by non-hydric soils." Mitsch and Gosselink (2000) and Marton et al. (2015) explain that these wetlands are formed by natural forces that create depressions on the landscape wherein precipitation, near surface (i.e., interstitial) water, or groundwater create saturated soil conditions for sufficient duration for hydric soils and hydrophytic plant assemblages to develop.

Tiner (2003) identified iconic examples of U.S. vernal ponds similar to those in central Canada that are the primary habitat for animal species that require relatively predator-free ponds for feeding or breeding, including many amphibians. Some amphibians including mole salamanders and wood frogs depend on the ephemeral nature of vernal ponds for successful offspring development. Due to periodic dry phases, these ponds preclude the establishment of permanent fish populations that would normally prey upon the amphibian early life stages (Burne and Griffin 2003). Species like wood frog (*Rana sylvatica*), fairy shrimp and many mole salamanders are dependent on vernal ponds for their reproduction. Vernal ponds provide critical habitat for significant species like the nationally threatened Jefferson salamander (*Ambystoma jeffersonianum*). The destruction of these ponds will result in the loss of the species that are dependent on vernal ponds for their survival and that cannot successfully complete their lifecycle in other habitats (Amphibian Voice 2004).

Many species of adult frogs and salamanders seek out vernal ponds early in the season and mate and lay eggs in shallow ponds. The young develop in the pools and metamorphose to their terrestrial form, after which they disperse into non-aquatic habitats in the surrounding landscape where they feed and hibernate (Kenney and Burne 2001; Gibbons 2003; Calhoun and deMaynadier 2008). It is the attribute of predator-free pools that appears to be critical (Zedler 2003). Many amphibians cannot successfully reproduce in permanent waters where the eggs and aquatic stages of the young are highly vulnerable to predation. Elimination of these "unconnected" wetlands could be devastating to amphibians (Semlitsch and Bodie 1998).

Vernal pools contribute to the connectivity of habitats through the establishment of dense pool networks. These networks provide important travel corridors between larger wetlands and support immigration and emigration across multiple pools (Leibowitz 2003; Compton et al. 2007). Species of turtles, snakes and birds use vernal pools as temporary sanctuaries during migration to rest, drink and forage for food (Mitchell et al. 2007). Vernal pools are also home to diverse shrub and herbaceous plant communities including Rice Cutgrass – Bulrush Vernal Pool, Woolgrass – Manna Grass Mixed Shrub Marsh, and Buttonbush Wetland. The vegetation often closely fits the Red Maple Forest Type (http://www.naturalheritage.state.pa.us/VernalPool_Vegetation.aspx). Some species are only found in the unique semi-permanent environments provided by the pools (Cutko and Rawinski 2008). The ecological relationships associated with vernal pools maintain forest biodiversity and contribute to many important ecological services ranging from carbon sequestration to water storage (Hunter 2007). In order to conserve these important services, proper understanding and management of potential threats is required.

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The integrity of vernal pool habitat is dependent on specific hydrologic, biologic, and chemical conditions. Anthropogenic stressors can compromise the stability of these conditions and lead to a loss of ecological function (Mahaney and Klemens 2008). Prominent stressors for vernal pools include urban or rural development, invasive species, and climate change. Development is considered to be the greatest threat to vernal pool habitat (Mahaney and Klemens 2008). Besides directly removing habitat, development can lead to many indirect threats, such as nonpoint source pollution and loss of connectivity. For example, runoff from roads and agriculture can end up in the vernal pool basin, compromising the chemical integrity of the receiving water body (Whigham and Jordan 2003). Like development, invasive species and climate change compromise the function of vernal pool habitat. Invasive species outcompete native species, leading to a loss in biodiversity (Cutko and Rawinski 2008). Climate change that involves reduced precipitation or alters precipitation pattern impacts the hydrology of vernal pools and may lead to shorter periods of inundation (Brooks 2009). This is a problem for species, such as mole salamanders, that require a certain amount of time in order for their offspring to complete metamorphosis.

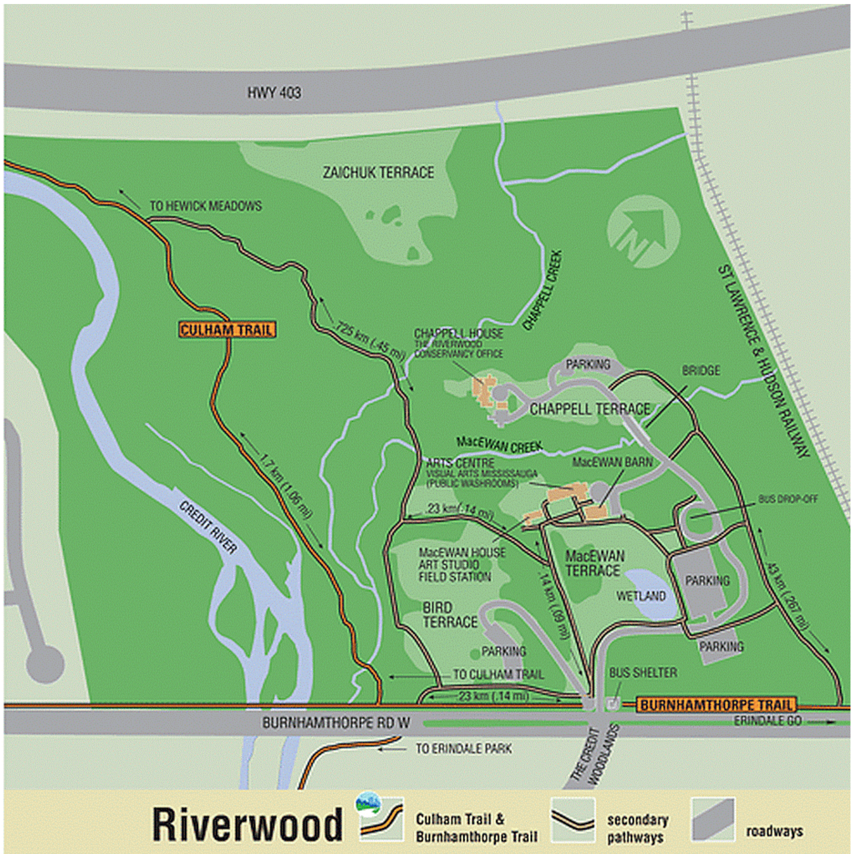
Threats from development are not limited to the pool basin. The forested upland surrounding the pools also provides essential habitat for vernal pool species and is similarly susceptible. For example, roads that intersect with upland habitat act as barriers for organisms trying to migrate to the pool (Leibowitz 2003). Moreover, destruction of habitat surrounding the pool degrades or eliminates other habitat necessary to complete the life cycle of vernal pool-dependent animals.

SOCIETAL BENEFITS

Citizen science is increasingly seen as a way to engage the public in science, improve scientific literacy and interest in science, and inform participants about particular topics, such as insect ecology, vernal pool conservation, or climate change (Lowman et al. 2009). This is a major departure from most of the history of citizen science, when projects were set up mainly to achieve scientific objectives. Instead, many are now being organized primarily as a means to

FIGURE 1. Example of a vernal pool school project in Ohio, where students helped create an educational sign for a local park. (http://www.vernalpool.org/treefrog/pop/06T-DIS-VPA.htm)

FIGURE 2. Location of the MacEwan Pond within Riverwood (Latitude 43.56582 Longitude: -79.67030). (http://www.theriverwoodconservancy.org/)



improve participants' scientific literacy and understanding of the topics they were studying (Bonney et al. 2009a). Miller-Rushing et al. (2012) believe that this renewed interest in citizen science, enriched with the perspectives and data provided by the long tradition of public participation in science, will broaden the engagement of the public in ecological research and lead to improvements in scientific education and insight.

Educators can use vernal pools to teach environmental and ecological concepts (Windmiller and Calhoun 2007). They use vernal pools for outdoor laboratories and in the development of associated education programs (Pressier 2000).

The Region of Peel upper tier municipality, in evaluating the significance of the vernal pool in Meadowvale, Mississauga, Ontario, points out that since a large portion of this natural area is public, opportunities exist to map, monitor and potentially control invasive species at that location. The use of the area by the public also presents an opportunity for educational messaging and awareness-raising by various means on themes revolving around the ecology of the area, environmental stewardship, and habitat restoration. Maintenance and enhancement, where possible, of natural buffers along the Credit River is encouraged by the municipality. Also encouraged is the maintenance of natural linkage between each of the sections of the natural area and adjacent natural and successional habitats (Region of Peel Meadowvale Station Woods. http://www.peelregion.ca/planning-maps/NAI/site_summaries/Meadowvale_Station_Woods.pdf).

The benefits of vernal pools are still an active area of research in northeastern North America (e.g., Calhoun and deMaynadier 2008; Lane and D'Amico 2010). Such research will increase our understanding of the conservation value of vernal pools. This value can be weighed against the value of proposed disturbances to help guide the decisions of land use planners.

Wetlands perform many ecosystem services, including aquifer recharge, carbon sequestration, biogeochemical processing, floodwater attenuation, improvement and maintenance of water quality and quantity, food and fiber provisioning, and maintenance of wildlife refuge (Lane and D'Amico 2010). Other research into ecosystem services provided by isolated or depressional wetlands have identified carbon sequestration in prairie potholes (Euliss et al. 2006), phosphorous and nitrogen processing and assimilation in emergent marshes (Whitmire and Hamilton 2005; Dunne et al. 2007), provision of water storage capacity in urban and agricultural landscapes (Gamble et al. 2007; Gleason et al. 2007), and pesticide degradation and/or sequestration in isolated pools in farmed systems (Skagen et al. 2008). Lane and D'Amico (2010) contend that water storage in wetlands has far-reaching effects. They state that "hydrology in a given site or suite of sites drives the creation and maintenance of vegetation structure and wildlife habitat, redoximorphic potential and microbial activities, and organic matter concentration for sorption of pesticides and other contaminants."

The social benefits of vernal pools have been less studied. Potential social benefits that should be researched in Ontario include the use of vernal pools in outdoor education, their aesthetic value, and their influence on air and water quality. Vernal pools provide an interesting ecological learning opportunity for students in Ontario's education system. Their small size, diverse ecology, and wide distribution make vernal pools an accessible teaching resource. Vernal pools often go relatively unnoticed due to their ephemeral nature. In fact, the public typically perceives vernal pools in negative light because they can act as mosquito breeding habitat. Vernal pool curricula in schools can increase public awareness of the benefits of vernal pool ecosystems and thereby encourage a positive perception for the public at large.

The use of vernal pools in laboratories and curricula is not new (Figure 1). Schools in the U.S. have collaborated with local governments, state governments, researchers, and conservation groups to develop lesson plans around vernal pool ecology (Gruner and Haley 2007). Some schools have gone so far as to create long-term monitoring programs for the vernal pools. In Ontario, the Ontario Vernal Pool Association now visits schools to give presentations on the importance of vernal pools.

CASE STUDY: MACEWAN POND, RIVERWOOD

Roughly 12,000 years ago a chunk of the last continental glacier broke off and sat surrounded by a lake formed by the melting ice in Mississauga, Ontario. In time the glacier would recede but the land-bound iceberg remained (Chapman and Putman 1984). Glaciers ground down rock and in the process created sand. The sand was blown about by the katabatic winds that blew off the glacier. Some of that sand swirled around the chunk of ice and when that iceberg finally melted a depression was left in the ground. The depression filled with water. The glacial lake retreated as it drained first down the Mississippi River valley, then through the Hudson River Valley and finally (as the lake levels decreased and the ice retreated further north) out the St. Lawrence (Meltzer 2010; Strock 2004). That depression (i.e., a kettle pond; http://geo.msu.edu/extra/geogmich/kettle_lakes.html) remained and is now called MacEwan Pond (Figure 2).

The character of the pond and its landscape setting have changed over the millennia as the climate changed. The pond was first surrounded by conifers, then by deciduous forests and finally by the mixed Great Lakes forest of today (Riley 2013). Through treaties with the Mississauga tribe the land along the Lake Ontario shore and the Credit River was purchased by the Canadian government in the early 1830s. It was then subdivided into 200-acre plots. By 1840 the land was being cleared around the pond. The great forests that had stretched unbroken from Quebec to the Great Plains were being cut down and used to fuel a new economy (Taylor 2013).

FIGURE 3. A variety of animals frequent MacEwan Pond: a) painted turtles, b) leopard frog, c) muskrat, and d) wood duck. (Photos courtesy of Nick Luymes)

The pond became a "farmer's pond" surrounded by fields of orchards and fenced off from cattle and farming practices (R. MacDonald, pers. comm., January 2017). For over 130 years its status as such remained unthreatened, however in the latter part of the 20th Century, there was concern over its future status as the character of the province was changing from an agricultural community where 80% of the population farmed to an urban community where 80% of the people worked in towns and cities (http://www5.statcan.gc.ca/subject-sujet/theme-theme.action?pid=3867&lang=eng&more=0&MM). In the mid-1980s, a small group of Mississauga residents lobbied to save the 160 acres of farmland around the wetland. At that time, the Mississauga Garden Council lobbied the City of Mississauga to keep it in the public purview. The City was undecided on their use of the property once they had purchased it in 1989 (https://localwiki.org/mississauga/Riverwood), but they had a vision to maintain it as a central green space for the public. The Mississauga Garden Council, now The Riverwood Conservancy (TRC; http://www.theriverwoodconservancy.org/), was successful in collaborating with the City and the Credit Valley Conservation Authority to secure "Riverwood" for the public.

Construction in Riverwood saw a new entrance road completed in 2005, and to keep the pond intact a berm was built (R. MacDonald, pers. comm. January 2017). A bio-swale was built to filter water from the parking lot before it reached the pond thereby reducing the impact of storm-water run-off. In 2006 the public could stand at the edge of the pond and see a variety of animals including turtles, frogs, muskrat and several bird species in the water (Figure 3) plus deer that came down to drink. A diversity of plants colonized its edges.

The pond now serves as a teaching resource where students are able to sample water and examine microscopic aquatic life. Through various programs at the Riverwood Conservancy, students learn how to chemically, physically, and biologically analyze water samples. They use probes, nets, GPS, and other tools to investigate the health of the ecosystem. Students get to explore human impact on the system, collect benthic invertebrates and other bio-indicators, and submerge themselves in their learning. Through the L.E.A.D.S. (Leadership in Environmental Achievements through Diversity and Skills) programs, secondary students are brought out of the classroom into the varied habitats of Riverwood (e.g., ponds, meadows and gardens)

FIGURE 4. Common Reed (*Phragmites australis*) in MacEwan Pond 2012. (Photo courtesy of Nick Luymes)

FIGURE 5. MacEwan Pond in 2006. (Photo courtesy of Nick Luymes)

FIGURE 6. MacEwan Pond in 2013. (Photo courtesy of Nick Luymes)

to connect students with nature through hands-on scientific inquiry (e.g., conduct field research and build technical and leadership skills) and also help prepare them for future careers in science and geography.

For travellers who stopped to visit Riverwood, the pond provided a window into historic hydrogeologic events. The last few years have seen the pond change into a true vernal pond and then recede into a virtually water-free depression (Taylor 2013). There are three major causes for this: 1) prolonged droughts, 2) the establishment of the invasive common reed (*Phragmites australis*; Figure 4), and 3) changes brought about by construction of gardens and parking lots adjacent to the pond (R. MacDonald, pers. comm. January 2017). Where historically water was retained most of the year in the pond, it is now dry for most of the year (Figures 5 and 6).

To the best of our knowledge, Phragmites first established itself in the pond in the summer of 2011. This was in the north-west corner of the pond, where it was outcompeting another invasive plant, purple loosestrife (*Lythrum salicaria*). By 2015, it had taken over 900m2 of the pond, with some populations of cattails (*Typha* sp.) still functioning, and sparse purple loosestrife stands intact. In 2016, The Riverwood Conservancy initiated efforts to control Phragmites by removing seed heads to stop potential seed spread and cutting down the stems and in the winter months to allow for the re-establishment of open water (Figures 7 and 8). From March until May 2016, open water habitat was re-established in the pond, enabling breeding frogs and waterfowl to return. Given the extensive root system and energy reserves of Phragmites, it is anticipated that the plants will grow back. In 2017 efforts will be made to cut down the plants in August and September, when most of its energy is in the shoot and belowground energy reserve is at its minimum. This should help weaken the plant, potentially decreasing stalk growth for future years. A priority of The Riverwood Conservancy is to bring the pond back to a healthy and resilient condition by aggressively addressing the Phragmites problem (as noted above) and dredging the pond to re-establishing open water habitat. Until the dredging is completed, it is unlikely that Phragmites will be successfully eliminated from the pond.

At present, following dredging of pond sediment to at least one meter's depth, the plans for pond restoration include deeper areas at the inlet for sedimentation, raptor poles, an accessible boardwalk and outdoor classroom, an accessible shoreline classroom with sitting rocks, and landscape restoration planting (Figure 9).

NEED FOR MORE GOVERNMENT ACTION ON VERNAL POOLS

The protection of wetlands has been identified as a priority by the Ontario Ministry of Natural Resources and Forestry (MNRF). The MNRF is currently creating a wetland conservation strategy that will outline the province's goals related to awareness, knowledge, collaboration and policy development. Ontario currently grants protection from

FIGURE 7. Common reed stand in MacEwan Pond, October 2013. (Photo courtesy of Kirushanth Gnanachandran)

FIGURE 8. Open waters re-established after Phragmites removal, March 2016. (Photo courtesy of Kirushanth Gnanachandran)

alteration and development to provincially significant wetlands (Ministry of Municipal Affairs and Housing 2014). A wetland is considered to be provincially significant if it meets specific criteria outlined in the Ontario Wetland Evaluation System (OWES). There are currently only four types of wetlands in Ontario that can be given the status of provincial significance: marshes, swamps, fens and bogs (MNRF 2014). Despite having a detailed protection strategy for large Ontario wetlands, vernal pools are not considered to be provincially significant unless they are part of a larger, provincially significant wetland complex (MNRF 2014). On their own, vernal pools are granted protection from development and alteration if they are known to be habitat for a "*species at risk*" (MNRF 2007). Only a select number of "*species at risk*" are known to be obligate users of vernal pools, so protection is limited to specific geographic areas. In order to protect the biodiversity and ecosystem services provided by vernal pools, additional protection is needed.

The dissemination of information regarding vernal pools has been sparse in Ontario. Vernal pools are mentioned in one of the appendices of the OWES, but only as a feature to make note of, if present, within the wetland under evaluation. On the government webpage for wetland conservation, the MNRF does not recognize vernal pools as classified wetlands. Similar webpages for U.S. states contiguous with Ontario (e.g., Michigan, Ohio, and New York) do recognize vernal pools as an independent class of wetland and will often include additional information dedicated to vernal pools. The small body of vernal pool research in the province may be related to this lack of special recognition. Moreover, there are no government research grants to encourage research in vernal pools.

The Ontario Vernal Pool Association (OVPA) is perhaps the most prominent organization promoting vernal pool awareness across the province. The OVPA organizes workshops, hikes and presentations for schools and municipalities (Mahaney and Klemens 2008). The OVPA stresses that the pools act as accessible outdoor laboratories where students can learn biological concepts such as biodiversity and metamorphosis, as has been the case with The Riverwood Conservancy. The OVPA also works with municipal governments to establish plots of land with vernal pools as natural heritage sites (Mahaney and Klemens 2008). Under the Planning Act, natural heritage sites in Ontario are protected from development that would incompatible with the current function of the site.

CONCLUSION

We recommend more attention be paid to the unique features vernal pools provide, and that their protection and restoration be a provincial priority. While the landscape around Riverwood's MacEwan Pond resembles little of its historic setting (Figure 10), work continues to bring back to health the function of the MacEwan Pond for the benefit of biodiversity of the region, and education of youth and adults about environmental science and conservation. ■

FIGURE 9. MacEwan Pond Restoration Plan. (Courtesy of The Riverwood Conservancy)

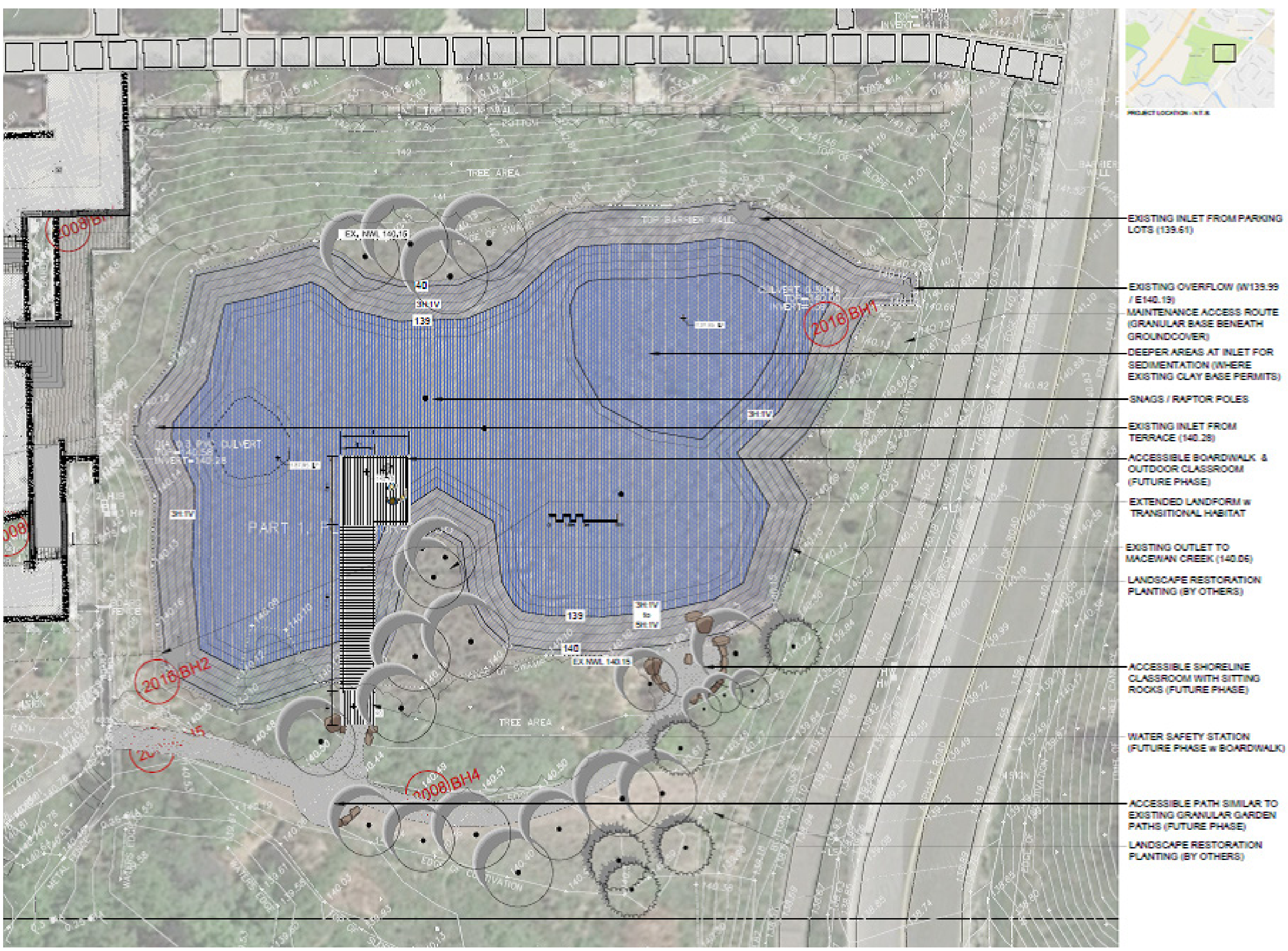


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FIGURE 10. Aerial view of MacEwan Pond, circa 1912, surrounded by forests and farmland. (Photo supplied by R. MacDonald)

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