**Otonabee Gravel Pit Restoration Plan**

Includes:

Final Report

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# Otonabee Gravel Pit Restoration Plan

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**Overview**

Ecological restoration can be a difficult task, as some ecosystems may never be able to return to their former state despite the greatest efforts. Extraction of aggregates from natural soil profiles is one typical example of this type of potentially irrecoverable modification which occurs worldwide (Frey & Pellerberg 2011). Typically, soils are removed, mixed, and compressed by equipment to the point where plant species once present may never be able to recolonize even once disturbance ceases (Kerbiriou et al. 2018). By extension, fauna that relied on and flourished in the presence of these primary producers may also remain absent, and often, these sites adjoin with species at risk habitats (Savanta 2008). Through extraction and associated processes, chemical contamination can also occur, which requires a unique restoration plan in and of itself (Peris et al. 2017). Sometimes, these extraction sites are then groomed for agricultural uses (Mackintosh & Hoffman 1985). However, assisted restoration and natural rehabilitation can still take place, and restored gravel pits are known as local hotspots for biodiversity and species at risk (Heneberg & Rezac 2018). Although restoration efforts will likely not “resurrect” the ecosystem formerly present, they can assist in the creation of a semi-novel natural environment, particularly suitable for native species at risk; a net positive for a region’s overall ecology. The Otonabee Gravel Pits present just such a case, and the Ontario government requires that decommissioned aggregate extraction sites be rehabilitated for these purposes (ARA 1990).

The Otonabee Gravel pit conservation area is a unique grassland-type landscape, providing habitats that benefit the ecology and human community of Peterborough. The property provides excellent recreational opportunities such as hiking, biking, dog walking, cross country skiing and bird watching. The diversity of people who utilize the property demonstrates the need for future research and commitment to enhancing the site's overall condition.

This incipient restoration plan will compile historical records of site characteristics, land uses and species composition, while also identifying important areas of study which have yet to be quantified. Using this information, we have created a long-term restoration and monitoring plan that can be implemented by the Otonabee Region Conservation Authority (ORCA) to further enhance the impacted areas of the Otonabee Gravel Pit. Through innovative research (supported by previous projects of a similar nature) and methodology consistent with ORCA's goals, we have project a desired baseline for the future health and condition of the property. Partnering with ORCA, and possibly even the Abandoned Pits and Quarries Rehabilitation Fund, we are now able to begin a feasible, detailed but flexible plan to maximize the potential of this site. The final report will incorporate the structure of the *Best Practice Guidelines for Aggregate Rehabilitation Projects* (Savanta 2008) as well as other case studies and scenarios from similar projects completed in Ontario.

**Site Summary (site history, species present, soi/water conditions, physical characteristics)**

The Otonabee Gravel Pit Conservation area is located on a 48.1 ha property (1) at 995 Crowley Line, Otonabee South Monaghan township, in Keene, Ontario (lot 11, Concession 12) (2). It is within the Peterborough EcoDistrict (6E-8) of the Lake Simcoe-Rideau EcoRegion of the Mixedwood Plains Ecozone (Wester et al. 2018, Ontario GeoHub 2023).

The gravel pit itself is situated on a property acquired by ORCA in December 1977, after which extraction continued for construction of local roads (4). Elevation at the site ranges from 186 to 189 meters ASL in most areas, and up to 210 m ASL on the drumlin which extends slightly into the Northwest corner (LIO MNR 2023). It is bordered by a swamp to the south and east along the Otonabee river. The aggregate license was surrendered in January 2023, and maximum aggregate tonnage was estimated at 137,000 tonnes (Ontario Geohub 2023). The closest aggregate pit that is still active is less than 1 km east across the Otonabee river (owned by J.L. Wittington Farms, Ontario Geohub 2023). No information regarding chemical contamination as a result of dumping or extraction-related activities at the site has been found. However, systematic and random tile drainage systems are used for agriculture at the first lot directly north of the site (owned by Traynor Farms).

The gravel pits consist of multiple ponds ranging in size, where the largest cell (which extends from east to west across the property boundary) is located closest to the Otonabee river along the south end of the boundary. Three other small ponds are located along the northeastern corner of the property, and are typically disconnected from one another, but have potential for interconnectivity during periods of heavy flooding. In 1980, Red and White Pine were planted north and south of the pit in an effort to restore the 11-acre forest community that once surrounded it. These are the predominant tree

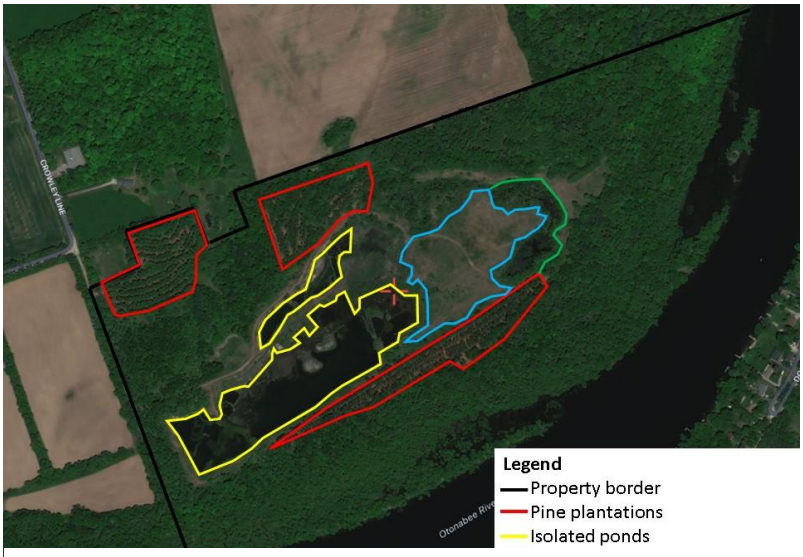


***Figure 1.*** *Property border, vegetation communities of Otonabee Gravel Pit Conservation area*

species in the area, along with other native species such as White Ash (Endangered), Black Ash, Black Cherry, Poplar, Willow, White Birch, Basswood and White Elm (Endangered). Invasive Dog-strangling vine and Common Buckthorn are prevalent in association with Red and White Pine on site (4). Many mature trees are present (1), but none of these have been recorded at DBH greater than 24 inches. The site's soils are moderate in depth, consisting of sandy loam and gravel underlayment. (4).

Throughout the majority of the site, the soil has been classified specifically as Lyons loam, whereas soils near the northwest corner (the edge of the drumlin) are Otonabee loam (Ontario GeoHub 2023). These types are commonly found in association with each other. Lyons Loam is typically found beneath drumlins or in depressed areas (often floodplains), and is usually saturated for an extended portion of the year (Gillespie & Richards 1957). These soils are poorly drained and seldom used for agricultural crops, and are known for being riddled with stones. However, they are fertile and well-suited as pasture soils. Otonabee Loam (as found on the drumlin extending into the site) is often used for agriculture in the Peterborough area, and although similar to the Lyons series, has a more developed organic horizon (Gillespie and Richards 1957).

Even before aggregate extraction ceased in 2004, the site began to re-naturalize independently. The term "naturalize" should be recognized by restoration ecologists as more than the resurgence of conditions from pre-impact. Rather, it should denote the presence of a fully functioning and healthy ecosystem that blends with surrounding systems, provides ecological value for a variety of species and has few areas of unutilized potential. As well, a lack of invasive species is not to be neglected.

Sedge and grass species are now common around the pit, and the margins of the pit (which has transitioned into a marsh) is home to patches of Alder and Willow trees. Mammals like White-tailed Deer have been sighted on the property, and presence of Beaver can be inferred through noticeable sign (tree chunk chewing, middens). 195 total bird species have been recorded at the site (6), including migratory species like Common Goldeneye, and semi-resident species like Pileated Woodpecker (1). Bullfrog, Map Turtle and Midland Painted Turtle have also been recorded, but there have been no fisheries surveys conducted (6). No fish species have been recorded within the gravel pits, but fish species may be present due to proximity to the Otonabee river allowing potential inputs from flooding events, as well as human introductions.

The gradual slope found along the north shores of some of the ponds create ideal nesting sites for turtle species during May and June, due to favorable substrate conditions (sand and loose gravel). The south facing bank, having full sun for the entirety of the laying season, provides warm temperatures for testudine egg incubation (Ontario Geohub. 2023). Site visits were undertaken to survey turtle nesting sites around the gravel pits, but were not completed during the nesting season. Nesting sites were identified by remaining shell debris, found predominantly along the north shore of the ponds with only one being found on the south side. Within the northeast corner of the largest pond, very shallow conditions are present, allowing for a variety of wetland grasses and woody plants (such as dogwoods) to grow. These shallow areas also provide habitat for nesting wetland birds such as Sora and Virginia Rail, which nest close to shallow water. Narrow-Leaved Cattail have been reported within the ponds and are considered non-native/invasive in the province of Ontario (Bhargav 2021).

Located at the East end of the property is a 2–3-acre grassland which historically served as an area for heavy machinery to operate, dump and collect aggregates. Today, this grassland is composed of many non-native and invasive flowering plants and grasses such as Brome and

Vipers Bugloss. The historic usage of heavy machinery in this location has caused significant soil compaction, which has prevented woody plants from encroaching into this area and has made it difficult for other flora to take root. This therefore decreases the overall diversity of habitat types that the property contains, while also contributing to lower diversity of species that utilize it. In recent years, the slow encroachment of woody plant species has become apparent, with first successional species such as dogwoods, poplars, and invasive buckthorn having been identified along the edges of the grassland. Further east of this grassland lies a small creek that stretches no more than a meter in width and 30 cm in depth, feeding into a moderately-sized vernal pond that has no connection with the gravel pit ponds to the west. This small stream is suspected of either being created from melt water or groundwater seepage. This type of habitat could provide exceptional breeding grounds for many amphibian species in early spring due to its precipitation-fed and relatively shallow water conditions (Reptile and Amphibian Conservation n.d). Gravel pit ponds are often fed by groundwater which flows easily through underlying rubble aggregates, making them cold (OSSGA 2010). Understanding how the nearby stream and are fed, as well as respective temperature regimes and chemical parameters will be crucial for identifying their potential for life.

**Knowledge Gaps and Proposed Field Surveys**

The property was purchased in 1977 and licensed as an aggregate pit (west end of the property). Presumably, mixed-wood forests, such as those found along property lines (as well as along the south end) consisting of Eastern White Pine, Poplar, Maple, Ash and Oak, were documented along the proposed west pond at the time. Exact details of pre-impact conditions are not readily available. Following extraction of aggregates, Red and White pine plantations located at both the North and South ends of the property were established in an attempt to reforest some of the land that had been previously disturbed (4). The Eastern White Pine plantation on the North side of the property is in good condition, with very little evidence to

support infestations from Pine Weevil (a well-known conifer pest in Ontario). Furthermore, the Red Pine plantations located at the North-Eastern corner, as well as the South side of the gravel

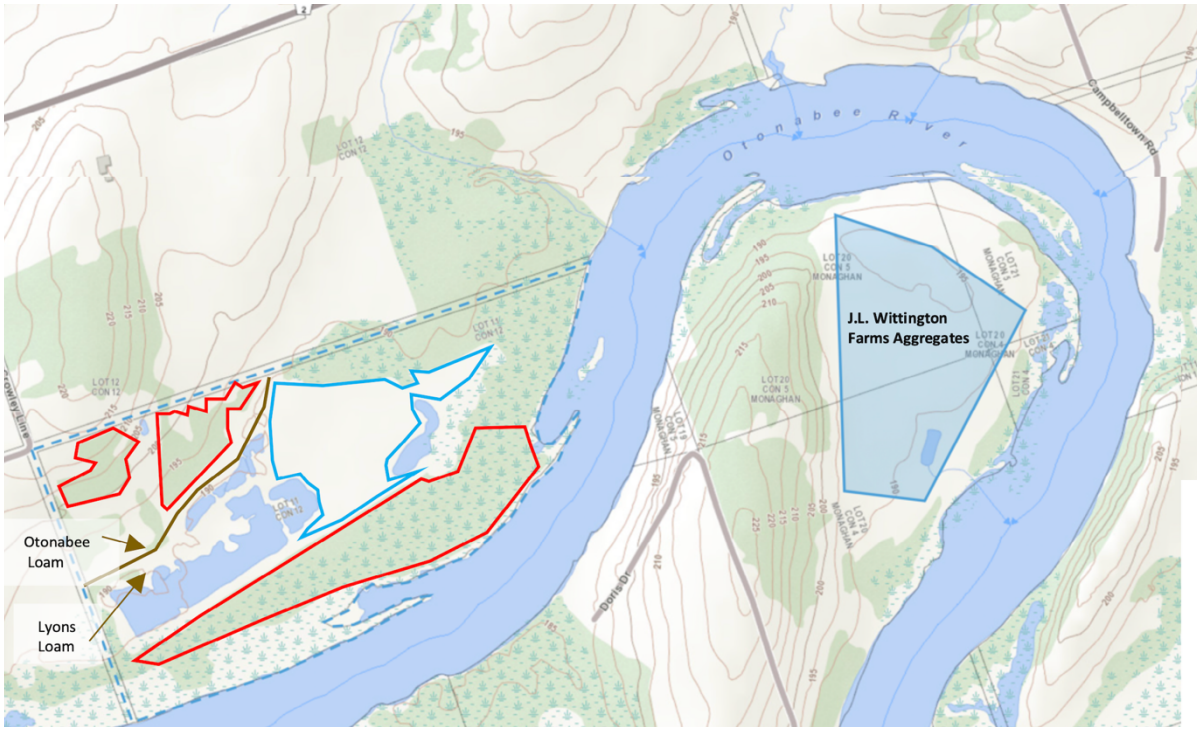


***Figure 2.*** *Otonabee Gravel Pit vegetation communities, soils, elevation and surrounding land features. Refer to legend used in figure 1.*

pit property, are also in good condition with the exception of moderate wood product found in the North-East (4).

The lack of information pertaining to historical habitats and land uses prior to 1977 makes it difficult to describe what the site “should” look like, and by extension, what the restoration “should” look like. However, some inferences can be made based on the surrounding canopy composition and general knowledge of species native to the area. A major knowledge gap emphasized by ORCA is the lack of data pertaining to pond depths and bathymetry, as well as the presence of groundwater sources, water chemistry parameters and temperature regime. Gaining knowledge of the bathymetry of these ponds could provide valuable insight for future management (species richness potential, risk of flooding/erosion, etc.). Lidar mapping provided

| History of the Otonabee Gravel Pit Conservation Area (information received from ORCA) | |
|---|---|
| 1974 | Squak-na-goss-ippi conservation area is established. Citizens and scholars recognize the future potential of the site as a model for restoration due to its location and size. It could be used for recreational purposes and natural studies. |
| December 1977 | Property acquired from Lauesen & Bourgard (original owners, no further information found) by ORCA to conserve shoreline wetland and obtain gravel source for Otonabee region roads. ORCA still allowed local operators to extract aggregates |
| April 1985 | Peterborough radio control club uses area for model airplane flying, which required the removal of vegetation from some areas |
| 1987 | Well-maintained hobby farms and some residential strips surround the site. |
| 1988 | MNR estimates that 560,000 tonnes of aggregates are present, the funds from which should be allocated for site restoration at the appropriate time. |
| March 1996 | Aggregates starting to deplete from certain sections, club members help report and control trespassing and vandalism at the site. Talk of restoring the site begins to take place once all aggregates are depleted and a short term contract is negotioated for aggregates with the region |
| January 2004 | Aggregates largely depleted |
| 2004-2023 | Natural succession/reclammation much more noticeable, ORCA recognizes that they will not be able to turn the site into a revenue-producing conservation area |
| 2006 | Peterborough flying/radio club's James Stewart agree to no longer use the site for flying model planes |
| January 2023 | Aggregate license surrendered |

***Table 1.*** *History of the Otonabee Gravel pit property. Information retrieved from Otonabee Region Conservation Authority (ORCA).*

by ORCA gives a visual representation of the contours of the ponds, but does not provide concrete data on depth or benthic sediments. Knowledge of water quality parameters (pH, conductivity, seasonal temperatures) to assess the gravel pits overall health would elucidate the potential for aquatic species richness. This knowledge would also be essential if merging ponds to the Otonabee river was ever desired, or if fish stocking programs were considered. These parameters could greatly affect the viability of certain fish species, as well as how the form of the ponds may change over time. The prospect of stocking native warmwater species (which may be suited to this location if cold groundwater sources are not present) that are less available to local anglers near larger waterbodies (but still native and coveted, such as Largemouth Bass) could also be considered. Investigating any nearby contaminant spills, or testing sediments and soils in and around the pit may be necessary also, as remediation should be done prior to fully implementing a restoration plan.

Little information was found on the aquatic species present in the gravel pits. Ontario Benthos Biomonitoring Network (OBBN) surveys are recommended to provide information on aquatic health, and overall aquatic species diversity in all ponds found at the site. The possibility of

incorporating a “Put-Take” fishery into the gravel pits would be dependent on the findings of OBBN surveys as well as the water chemistry and bathymetry data findings, since these aquatic parameters have direct correlation with the success and health of this type of fishery. The Ministry of Natural Resources holds a property in Millbrook, Ontario which is home to two relatively large ponds which are indirectly connected with Baxter creek and surrounding tributaries in Peterborough County. These ponds are stocked with Brook Trout and give many Ontario residents the opportunity to harvest Brook Trout sustainably, while simultaneously taking fishing pressures off nearby native Brook Trout populations. Brook Trout (as well as other cold-water specialists) can be extremely sensitive to changes in water quality (temperature, salinity, pH, and oxygen), and the Otonabee gravel pits would have to meet requirements to sustain such a put-take fishery. Groundwater, which could be indicated by the presence of watercress or reddish substrate colouration from iron precipitates (North-South Environmental 2005), could be used as a proxy for groundwater. This would incentivize measurement of annual temperature regimes and dissolved oxygen content to determine suitability for coldwater species.

**Brief Review of Current Literature on Gravel Pit Restoration**

Restoration plans for all impacted sites must consider the features needed to accommodate a variety of species, rather than focus on the needs of one particular community. Generally, extraction of aggregates is only temporary on any land, meaning that natural succession or rehabilitation will take place once this usage has completed (OSSGA 2018). Succession-based designs are crucial for proper rehabilitation, as this allows for the gradual creation of a system which blends with and complements the surrounding environment (Trimble and Seibert 2002). In the case of the Otonabee gravel pit conservation area, restoration for maximum ecological value will be emphasized. Gravel pit restoration is often at odds with demand for aggregates

(Trimble and Seibert 2002), but this is not of any concern in the case of the Otonabee gravel pit, as operations have long ceased.

It is difficult to quantify the true progress of a restoration plan from a standpoint of ecological value and function, and no exact criteria truly exist for this (Kerbiriou et al. 2018). This is largely because these sites are rarely inventoried before being commissioned for extraction and they are often irrevocably modified by extraction activities. One study claims that spontaneous natural succession can achieve valuable restoration within 25 years, particularly if native species communities surround the site (Rehounkova & Prach 2008). However, invasive species in surrounding environments can negate this type of effortless success, as it allows for them to exploit new regions and dominate. Spontaneous succession has been suggested as an optimal strategy as opposed to forestry reclamation, the latter involving reformation of the land and refertilization. This often encourages the growth of monocultural forest ecosystems with lower species richness and fewer opportunities for species at risk (Sebelikova et al. 2020).

Natural spontaneous succession is not always perfect or predictable. Often, abandoned gravel pits are simply left untouched until natural succession assembles new biotic communities, which have little resemblance to those that were once present (Kerbiriou et al. 2018). Oligotrophic systems sometimes develop from this, creating pockets of unique biodiversity to supplement for even older bygone ecosystems, often supporting locally imperiled species (Heneberg & Rezac 2018). Occasionally, soil profiles and water/soil chemistry are changed to the point where little to no true succession supporting sufficient biodiversity can take place, in which case, modifications are necessary (Peris et al. 2017). Being that gravel pits usually turn into ponds or small lakes once abandoned, efforts to bring the system back to its original form are extremely costly and not practical. As such, making the most of the new formations present at the site will result in the most feasible and meaningful restoration.

The key feature of most gravel pit restoration projects is the pit itself, which can offer a novel aquatic ecosystem. Studies have shown that adding high organic matter substrates to the bottom of these systems can increase carbon storage, denitrification (creating protective pH buffer zones around wetlands) and plant growth (Mchergui et al. 2014). To promote bank stabilization and cover for littoral zone species, woody riparian vegetation (like willow and alder) can be effectively propagated through natural seedfall from nearby wetlands and shoreline trees in proximity to gravel pit systems (Roelle & Gladwin 1999). Woody debris, wood chips, hay or other materials could in their own right act as stabilizers, but may be necessary to fortify soils and ensure proper plant growth. Arid-tolerant native species, such as Big Bluestem and Switchgrass (terrestrial) may be a substitute for shrubbery if conditions are deemed unsuitable. Combined with any necessary slope modifications, bank stabilization is a proven way to encourage amphibian biodiversity (Klimaszewski et al. 2016). Promoting submergent or emergent vegetation within the pond itself requires a much steeper slope. Until bathymetry surveys have been performed, potential for aquatic plant growth remains unknown. The presence of larger nearby water bodies and associated flooding is often a concern in gravel pit restoration and has been shown to impact the usage of these sites by migratory birds (Harrison & Whitehouse 2012).

Threatened species, such as bats, provide valuable ecosystem services and feed heavily on insects. Therefore, gravel pits, often supporting an abundance of flying insects due to their lotic water bodies and lack of thick canopy, make excellent bat feeding habitats. Encouraging the health of aquatic ecosystems created from extraction operations (through vegetation communities, and possibly by connecting to larger water bodies nearby) as opposed to modifying them to achieve original land features may provide a unique opportunity for facilitating bats (which may never have been present in the area previously). Additionally, in the

surrounding terrestrial systems, plant community diversity can often be increased by encouraging the presence of wild or domestic grazing species at impacted sites. However, depending on the site, this may be less suitable, as grazers have been shown to have some impact on terrestrial arthropod species abundance, especially detritivorous insects (Helden et al. 2018).

**Restoration implementation**

The overall goal of this restoration plan will be the creation of an ecosystem which blends with surrounding environments (aquatic and terrestrial), is largely free of defects associated with surrounding ecosystems (invasive species, disturbance, etc.) and maximizes the potential of the site.

ORCA has suggested that the gravel pit marsh and ponds could be hydrologically connected to the nearby Otonabee river as a part of the restoration project (3). However, given the possibility that this could change the size, shape and chemistry of this unique system, it may not be the best plan for restoration emphasizing local biodiversity value. Information obtained from ORCA on the site's history, as well as the abundance of literature pertaining to gravel pit restoration will allow us to formulate a precise (but flexible) plan for site restoration. Since most of the property is very nearly at the level of the Otonabee, the chance of flooding appears quite high, in which case, facilitating a novel and transitional ecosystem (semi-terrestrial/aquatic) should be part of our goal. Given that soils in the flood plain area of the site (surrounding the ponds to the edge of the river bank) are thin, poorly drained and rich with nutrients (Gillespie & Richards 1957), increased chances and extent of seasonal flooding could leach nutrients needed for plant growth and saturate the soils for an extended period of time, eliminating more terrestrial species. In addition, water chemistry and substrate in the gravel pit ponds may be unique in comparison with the Otonabee, and connecting these systems may homogenize the ponds and

prevent the development of a unique pocket for novel biodiversity. Otonabee and Lyons loams are also quite thin, making them more suitable for grass or shrubland species as opposed to large trees. Monitoring and individualized protection of SAR plants and trees that have been recorded on site (i.e. American Elm, White Ash, Butternut, iNaturalist) can be undertaken also.

Invasive species establishment is always a source of concern when conducting or attempting to restore a site to its maximum natural potential. Many invasive species are present in the Peterborough area, including Common Reed (*Phragmites australis*), European Buckthorn (*Rhamnus cathartica*), and Dog-strangling Vine (*Vincetoxicum rossicum*) as well as Spongy Moth (*Lymantria dispar*), Rusty Crayfish (*Faxonius rusticus*), and Banded Mystery Snail (*Callinina georgiana*). Many invasive species likely already occur in abundance and are likely beyond the possibility of elimination such as Common Reed and Spongy Moth. Mobility and motility of invasive species like these make small-scale exclusions impractical and very unrealistic. However, the conservation area benefits from geographical separation to any nearby major roads, which are a main vector for invasive species transportation. In addition, the well-established forested border in all directions can deflect wind-blown seeds from nearby areas. Connecting to the Otonabee River could also allow the introduction of species like Common Carp, Round Goby and Zebra Mussels, which could be devastating to a system this small.

Cultural Meadows are characterized by prevalent invasive species and less than 25% tree cover (Savanta 2008). Usually, these ecosystems succeed into thickets (prevalent woody shrubs) provided that soil conditions are suitable. Given that soils are poorly drained and often saturated at the site, it seems most likely that grasses and forbes will dominate the area for the foreseeable future, and shrubbery will be scattered in patches. Management of already established invasive shrubs and plants, such as European Buckthorn, can be conducted through intensive removal strategies. This, in addition to the encouragement of native species

establishment should create an unsuitable living environment for these invasive plants. The site is located on the border of Ontario's 5a/5b plant hardiness zones in central Ontario, meaning that shrubby species found even just slightly north and further into the Canadian Shield (Witch-Hazel, Alternate-Leaved Dogwood, Striped Maple) will likely be unsuccessful if planted here (Miller & Mackintosh 1987). Species like Red Osier Dogwood should therefore be considered for introduction. If the extent of Buckthorn or other invasive shrubbery is deemed as a hindrance to planting and establishing native species during field surveys, aggressive removal programs involving mowing, tarping or de-rooting will be necessary. Red Pine, although an Ontario native, prefers acidic soils, and was likely not present before the area was developed (often planted to harvest as telephone/service poles, City of Peterborough 2003). If feasible and unharmful to the system overall, removal of these trees and replacement with locally common species (White Cedar, Poplar) may be necessary. Ensuring a diverse ecosystem of native plants should encourage insect diversity and competition against invasives. Regarding aquatic invasives, the pit benefits from its isolation from the nearby Otonabee River. However, flooding may increase the chances of transportation of aquatic invasives. Ensuring a physical barrier, such as a hill or berm may assist in this issue, although it is not expected to be a major problem.

In addition to potential spread of nearby invasive species, the gravel pits lie in a rural area surrounded by agricultural fields just beyond the thin buffer of forested lands. Fertilizers and pesticides used in these fields may enter the gravel pit through groundwater seepage or runoff, potentially leading to nutrient overloads or eutrophication. The aforementioned water quality surveys suggested would certainly determine if this waterbody has been exposed to these pollutants.

Information regarding the slope of the gravel pit banks has not been obtained. In order to assess whether remediation is needed, a calculation of the slope angle is necessary.

Regulations state that a 3:1 slope ratio is needed for minimal erosion risk with the top of slope outside 30m of the licensed area boundaries. However, in the case of the gravel pit, an exception has been proposed for the slope on the south side of the wetland to be left as is due to it being already well vegetated. In addition, an exception has been proposed to disregard the 30m boundary regulation on the north side of the wetland. This would eliminate the need of filling in the wetland, in-water works, and outsourcing materials for the achievement of this slope. Once target goals have been established and met, a final report on overall progress and state of the site should be created and made available to the public for review.

Regular monitoring, although not mandated for restoration projects, is also a crucial component for ensuring restoration goals are met. Regular monitoring of water levels and soils saturation throughout the year, as well as soil and water chemistry testing (pH, dissolved oxygen, etc.) will help determine the site's suitability for different aquatic species and plants, and help anticipate the direction that natural rehabilitation will take. Annual vegetation surveys to determine composition and overall species richness would be a good gauge of overall progress as well, and may create the incentive for further invasive species removal or native species introduction (Savanta 2008).

Funding for restoration will likely be provided by ORCA, local conservation partners, donors, and rehabilitation funds created through aggregate extraction (Savanta 2008). Our restoration plan will follow these main points:

1. Ensure that this already impacted site receives as little stress as possible going forward to keep restoration from being any more difficult, and conduct surveys to determine if any other SAR recorded within 20 km of the site are present (Savanta 2008)

2. Prevent the further ingression of invasive species, especially the aquatic systems, while controlling/removing invasives present and encouraging native species
3. Implement physical barriers (artificial or natural, if needed) to buffer any outside stressors such as flooding, erosion or nearby pesticide/fertilizer usage
4. After measuring soil, air and water quality parameters, determine the site's potential for fish stocking programs or other native species introductions (such as vegetation for wildlife breeding, shelter and pollination) to increase the site's recreational utility and biodiversity
5. Develop an annual monitoring program to track progress obtained by assisted natural rehabilitation and spontaneous succession

Our goal is to encourage and nurture a semi-novel ecosystem (to some degree, already present) which blends with surrounding landscapes, while still offering a unique destination for naturalists and recreational users. Utilizing the unique land features created by the extraction process (rather than backtracking through an attempt at ecosystem "resurrection"), we can develop a pocket community which offers excellent harborage and permanent residence to species at risk, to be presented as a flagship model for upcoming restoration projects throughout the province and the world.

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