Monitoring Plan for the Emergency Use Registration Phragmites Control Project-2017

Ministry of Natural Resources and Forestry
Natural Resources Conservation Policy Branch, Natural Heritage Section
Southern Region, Aylmer District
Ontario Parks, Southwest Zone

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Ontario

Table of Contents

1.0 Introduction

Phragmites (*Phragmites australis* (Cav.) Trin. Ex Steud) is an invasive plant expanding rapidly within the coastal wetland marshes at Rondeau and Long Point, which is impacting numerous species at risk and threatening the ecological integrity of these critical habitats. Phragmites is a perennial grass that forms dense mono- specific stands, growing to heights exceeding five metres, with an extensive underground network of roots and rhizomes. In order to halt the advance of this invasive plant, the Ministry of Natural Resources and Forestry (MNRF) will be conducting aerial and ground herbicide treatments within aquatic habitats at Rondeau (~82 hectares) and Long Point area (~600 hectares) in fall 2017. This pilot project required approval of an emergency use registration of Roundup Custom ® For Aquatic & Terrestrial Use Liquid Herbicide by Health Canada's Pest Management Regulatory Agency (PMRA), as there is no product registered for Phragmites control in aquatic habitats in Canada at this time. This work continues the pilot initiated in 2016 as part of the Emergency Registration, and builds upon previous and on-going Phragmites control efforts that have been undertaken at the two sites in terrestrial habitats.

Glyphosate (N-(phosphonomethyl) glycine) is a broad-spectrum systemic herbicide that has been registered by the U.S. Environmental Protection Agency since 1971 for use in aquatic environments. It is very effective for the control of perennial weeds, such as Phragmites, because it is quickly translocated from the leaves of treated plants to other parts of the plant, including rhizomes and tubers. Its use as an aquatic herbicide in wetland restoration initiatives within the Great Lakes basin has been well documented, with large scale treatments resulting in significant reductions in Phragmites and increased plant biodiversity (Getsinger et. al. 2006, Ailstock et. al. 2001, Teal and Peterson 2005, Lombard et, al. 2012, Back and Holomuski 2008).

Glyphosate is a valuable tool within ecosystem restoration initiatives because it is relatively nontoxic to fish and wildlife (its mechanism of action is specific to plants (Tu et al. 2001)) and it adsorbs strongly to soil particles once it enters the water, thus preventing excessive movement in the environment (Schuette 1998). In water, the two primary means of dissipation are binding to sediments and microbial breakdown. Glyphosate also does not bioaccumulate, biomagnify, or persist in a biologically available form in the environment (Thompson and Solomon 2003). Glyphosate is readily

degraded to aminomethylphosphoric acid (AMPA) by soil microbes and carbon dioxide. AMPA is non-toxic and degrades microbially more slowly than its parent compound (Tu et al. 2001). There is a significant body of literature that indicates that the risk to aquatic organisms from the use of glyphosate in wetlands and overwater situations is negligible or very small (Solomon and Thompson 2003).

To minimize the amount of herbicide required for the application, the addition of a non-ionic adjuvant is required. An adjuvant is a molecule or compound that reduces the surface tension of water, enabling the herbicide to wet and penetrate the leaf foliage. The pilot project will use the adjuvant Aquasurf® in combination with glyphosate. The adjuvant to be used by MNRF for the pilot project is prescribed on the glyphosate label and has been approved by PMRA based on its low environmental risk. Aquasurf® is already registered and classified for use in Canada and Ontario respectively.

2.0 Monitoring

2.1 Objectives

Although the pilot project's proposed use of glyphosate in aquatic habitats for control of Phragmites is not unique in the United States, it represents the first time this work has been undertaken in Canada. The results of this pilot project may inform similar control initiatives in the future within Ontario, and Canada. Thus, MNRF has partnered with the University of Waterloo and other partners (including the Nature Conservancy of Canada, and Bird Studies Canada) to monitor and analyse the following, as part of the pilot project:

1. Efficacy of the herbicide treatment in eradicating Phragmites;
2. Effects of the control activity on sensitive emergent coastal marsh communities;
3. Effects of the control activity on fish and fish habitat;
4. Fate of glyphosate, AMPA and the adjuvant at the treatment sites, and their dispersal from treatment sites; and risks to aquatic biota and the wetland food-web.
5. Glyphosate concentrations in surface water samples adjacent to community of Long Point, Turkey Point and residences near the outlet of Big Creek

2.2 Monitoring Summaries

To address MNRF's five monitoring objectives identified above, a suite of monitoring approaches will be required. What follows below is a brief outline of the proposed monitoring techniques. Detailed methodologies for each aspect of the monitoring program are provided within Appendices A, B and C.

2.2.1 Herbicide Treatment Efficacy

This monitoring will address monitoring objective #1 (Monitor the efficacy of the herbicide treatment in eradicating Phragmites). Twenty plots within treatment sites and 20 control plots were established at both Long Point's Crown Marsh and Rondeau Provincial Park in August 2016 prior to aerial herbicide application in September 2016. These sites were selected to include both medium and high density Phragmites patches, and are being evaluated post-treatment in 2017 and will be resampled in 2019 and 2021, to determine mortality and/or survivorship of Phragmites. The methodology for implementation is outlined in Appendix A.

Assessment of Herbicide Drift during Aerial Application

Both aerial and ground herbicide application will be undertaken within weather conditions that are prescribed on the label, and using equipment designed to minimize drift and impacts to non-target species. During application, the contractor will record current weather conditions and track the actual flight path and herbicide treatment, to assist with evaluation of drift post-treatment. As in 2016, MNRF will undertake surveys to evaluate the occurrence of drift on non-target plants.

Prior to aerial application, Phragmites areas (polygons) are mapped based on a visual survey. The polygons identified for herbicide treatment are then optimized considering the constraints of the aircraft such as swath width (determined during aircraft calibration, based on aircraft configuration and spray release height). The aircraft's application navigation software (Ag-Nav) optimizes the treatment polygon to get the best coverage for the Phragmites polygon, including spray aircraft direction and when to turn the booms on and off. This significantly reduces the opportunity for herbicide drift to non-target vegetation.

MNRF will assess the occurrence of non-target vegetation through the following means; 1) Upon completion of the spray; the aerial applicator will provide MNRF maps of areas

that were actually sprayed, generated by the aircraft's on-board Ag-Nav system. This can be used to assess how the actual treatment area compared to the planned treatment area.

2) Similar to 2016, with the technology that MNRF has available, it will track the post-spray vegetation effects by comparing pre and post-spray imagery (2017, 2018). This can be used to infer the impact of the herbicide outside of the intended spray area by measuring the differences between vegetative chlorophyll responses within the drift zone as defined by the herbicide label. This imagery can also be used to make inferences regarding the impact of herbicidal spray on non-target vegetation. In 2017, this assessment will be undertaken on the aerial application being conducted at Long Point Crown Marsh (approximately 30 hectares).

2.2.2 Effects on Sensitive Emergent Coastal Marsh Communities

This monitoring will address monitoring objective #2 (Monitor effects of the control activity on sensitive emergent coastal marsh communities). The protocol for this monitoring are also incorporated in Appendix A.

Vegetation Composition

In 2016, the 20 treated sites and 20 control areas at Long Point and Rondeau were inventoried prior to control, to establish the baseline vegetation composition in Phragmites invaded marsh where water depth is 10-50 cm deep. In 2017, these locations were again inventoried to determine the initial post-treatment vegetation composition. Follow-up monitoring is planned in 2019 and 2021, to establish mid-term recovery of treated areas and contrast this with vegetation composition in untreated control areas.

It should be noted, that the most integral component of the monitoring program for assessing effects on the coastal marsh communities is documentation of vegetation changes. Vegetation is the most sensitive component of the biota to glyphosate application. Work by Dr. Laura Borgeau-Chaves at Michigan Tech Research Institute on Phragmites control with herbicide demonstrated that the biotic integrity of vegetation, measured using the Great Lakes Coastal Wetlands Consortium's IBI, was most responsive to control efforts in comparison with birds and amphibians. Experimental treatment of wetlands with glyphosate from the Gagetown Experimental Wetland

Complex in New Brunswick (Dr. Leanne Baker, Dr. Jeff Houlahan, and Dr. Karen Kidd, among others) also concluded that vegetation is the most sensitive component of the biota to glyphosate application. In this series of experimental additions of glyphosate to wetlands, the effects observed in higher trophic levels were attributed to the indirect mechanism that glyphosate affected the plant community, and the algae and chironomids responded to changes in the vegetation. Further, sensitive ecological communities identified by NatureServe are of explicit conservation concern in Rondeau Provincial Park, and these are defined by their vegetation. Thus, vegetation composition serves as a sentinel for potential effects of glyphosate application on higher trophic levels.

Amphibians

MNRF is working with project partners such as the Nature Conservancy of Canada and Bird Studies Canada to support additional monitoring of frogs and birds, through existing initiatives such as the Marsh Monitoring Program (MMP). The MMP has collected data at survey locations at both Rondeau and Long Point for several decades, to assess populations of frogs and birds within individual marshes (such as at Long Point and Rondeau) and within the Great Lakes basin. The data collected at Rondeau and Long Point survey locations will help to identify changes to frog and bird populations as a result of Phragmites control.

2.2.3 Effects on Fish and Fish Habitat

This monitoring will address monitoring objective #3 (Monitor effects of the control activity on fish and fish habitat). The protocols for this monitoring are outlined in Appendix B.

No negative impacts to fish or fish habitat are expected to occur as a result of the herbicide application; indeed, it is expected that Phragmites control will ultimately result in beneficial improvements to aquatic values for both locations. In 2016, water samples taken by the University of Waterloo immediately after herbicide treatment (24 hours), and one month post treatment at both Rondeau and Long Point were all well below the Canadian Council of Ministers of the Environment (CCME) long-term exposure threshold for the protection of aquatic life.

The herbicide application is intended to be applied only to dense stands of Phragmites, not to open water; and the aerial treatment will be undertaken in a manner to avoid the potential for drift (see objective 2 regarding monitoring that will occur to assess the occurrence of impacts to non-target vegetation).

However, both Rondeau Provincial Park and Long Point Crown Marsh will be monitored for any incidental observations of impacts to fish, in combination with other monitoring that is already occurring at the two sites. It is proposed that monitoring intervals will occur prior to treatment, 24 hours post-treatment and 2 to 3 days post-treatment.

This will also include before and after control photo-documentation of the treatment sites to document physical changes in Phragmites stands and plant breakdown.

Similar to 2016, a Before-After Control Impact (BACI) monitoring design will be specifically applied to the Long Point Crown Marsh, to assess any fish mortality in ponds adjacent to treated sites vs. untreated sites. These ponds will be monitored prior to treatment, 24 hours post-treatment, and 2 to 3 days post-treatment.

2.2.4 Pesticide Fate in the Environment

This monitoring will address monitoring objective #4 (Assess the fate of glyphosate, AMPA and the adjuvant at the treatment sites and their dispersal from the treatment sites). This work will include continued monitoring of the 2016 herbicide application to confirm that levels have returned to baseline, and monitoring of the new sites proposed for treatment in 2017. The monitoring plan will also include work to assess risks of the herbicide application to benthic invertebrates, microbial communities and the wetland food web. The protocol for this work is outlined in Appendix A.

2.2.4.1 Assessing residue accumulation at Rondeau and Long Point

Areas treated by aerial application in 2016, will be assessed to determine if glyphosate, AMPA and the adjuvant have returned to baseline. Water and surface sediment samples will be collected at sites at both Long Point Crown Marsh and Rondeau Provincial Park, prior to the 2017 treatment.

2.2.4.2 Transect sampling of 2017 application adjoining Long Point Bay

At Long Point Bay (Long Point Crown Marsh, Big Creek and Turkey Point), paired transects will be established, with one transect originating from Phragmites planned for

treatment in 2017, and the other transect serving as a local reference in an area where no treatment is proposed in 2017. The transect sampling stations will be situated 1) in Phragmites at the edge of the open water, 2) in the open water adjacent to a treated Phragmites treatment polygon, 3) 10 m away, 4) 25 m away, 5) 50 m away, and 6) 100 m away from the treatment polygon boundary. Water and sediment samples will be collected at each of the treatment and reference transect stations, prior to, within 24 hours of treatment, and 30 days post treatment.

To evaluate the risks of the herbicide application to aquatic biota, the water and sediment samples will be analyzed for glyphosate, AMPA, and total alcohol ethoxylates. The three locations for sampling (Long Point Crown Marsh/Long Point Provincial Park, Big Creek, and Turkey Point) represent different exposures, hydrology, and substrate, which will provide good representation of conditions across Long Point Bay.

To support investigation of the effects of the treatment to benthic invertebrate communities, samples will also be collected at the treatment and reference transects at Long Point Crown Marsh and Turkey Point, prior to, within 24hours of and about 30 days post treatment. Samples collected within the 0m transects, will be priority analysed, and a decision to conduct additional analyses will be determined on if the glyphosate, AMPA, or alcohol ethoxylate water or sediment samples exceed the thresholds of concern established by the Canadian Council of Ministers of the Environment. The benthic invertebrates will be analysed to the lowest practical level by Dr. Jan Ciborowski's research laboratory at the University of Windsor.

2.2.4.3 Risks to biofilms and the food-web

To evaluate the risks of the herbicide application to microbial communities and the wetland food web, biofilms (significant proportion of which are periphyton or "attached algae"), a BACI design will be employed to collect biofilms before and after the herbicide application at a pond within the 2017 treatment area, a pond within the 2016 herbicide application area, and a control pond that has been exposed to herbicide application. Stations for biofilm collection will also be established at the 0m transect stations at Long Point Crown Marsh, and Big Creek. Biofilm community composition and diversity will be compared among ponds on each collection date to determine if there is an effect of the herbicide on the biofilm community.

In the lab, biofilms harvested from each station on each sampling date, will be sequentially composited, homogenized and sub-sampled, to yield a single bulk sample which will be sub-sampled for analysis of glyphosate and AMPA, and the remainder will be frozen for use in a tadpole feeding trial proposed in summer of 2018. The tadpole feeding trials will provide a mechanism to assess the occurrence of effects of the herbicide application on the dietary value of biofilms.

2.2.4.4 Water sampling adjacent to communities of Long Point, Turkey Point and residences near the outlet of Big Creek

This monitoring will address monitoring objective #5 (Monitor glyphosate concentrations in surface water samples adjacent to the community drinking water intakes that are near the herbicide application areas at Long Point, Turkey Point and the mouth of Big Creek). The methodology for collection of these samples is described in Appendix C, and also includes a description of the notification and contingency plans to be undertaken if the water samples collected exceed the Ontario Drinking Water Quality Standard for glyphosate.

2.2.5 Additional Data Collection

There will be a need to collect some additional data to help inform data analysis. The following have been identified as necessary:

2.2.5.1 Sediment Composition Sampling

Given that sediment type is an important factor that should be considered during pesticide fate analysis; a one-time sample collection and analysis will be required from all sediment sampling sites, to determine percent composition (i.e. percent sand, silt and/or clay), total organic content, and concentration of iron. Composite sediment samples will be collected, as per the sediment sampling methodology outlined below.

2.2.5.2 Turbidity

Given that glyphosate may adhere to suspended particles, the total suspended solids in water is an important factor that should be considered during pesticide fate analysis; turbidity will be measured at each sampling site as each water sample is collected. Water samples will also be filtered on pre-combusted GF/F filter papers for analysis of total suspended solids from each water sampling station.

3.0 Reporting

The results of the monitoring plan will be summarized in one or more reports, and shared with other agencies, such as MOECC, DFO, and PMRA to inform analysis of efficacy of the pilot project to control Phragmites and future requests for Emergency Use Registration of glyphosate for the control of Phragmites in aquatic habitats.

Results of the pilot project and the monitoring plan will also be shared with the public, through presentations to local community groups, and at provincial forums such as the Ontario Invasive Plant Council's Provincial Webinar Series and the Ontario Phragmites Working Group's annual meeting.

Scientists with the University of Waterloo also intend to publish the results of the research and monitoring for this pilot project within peer reviewed journals, and present information on the pilot project at scientific conferences.

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Appendix A:

2017 monitoring plans for objectives 1, 2 and 4:

Objective 1) Herbicide Treatment Efficacy

Objective 2) Effects of the control activities on sensitive emergent coastal marsh communities

Objective 4) Fate of glyphosate, AMPA, and the adjuvant at the treatment sites, and their dispersal from treatment sites; and risk to aquatic biota and the wetland food web.

2017 MONITORING PLAN FOR THE EMERGENCY USE REGISTRATION PHRAGMITES CONTROL PROJECT

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Efficacy Monitoring

Objective 1: Herbicide Treatment Efficacy

This monitoring will address the questions: 1) How effective is herbicide application over standing water in eradicating invasive *Phragmites australis* and encouraging regrowth by resident emergent marsh species?; 2) Does efficacy differ with standing water depth?

Approach

The monitoring program follows a BACI regression design. Forty plots were established in each of Crown Marsh and Rondeau Provincial Park in August of 2016. These plots were divided equally between medium and high density *Phragmites australis* patches that were treated by the aerial application of glyphosate with an alcohol ethoxylate surfactant in September 2016 (n = 20 treatment per marsh) and medium and high density *Phragmites australis* patches that were left untouched (n = 20 control plots per marsh). The location of these plots is presented in Figures 1 & 2. The treatment and control plots were paired by water depth and stratified to include both medium and high density *Phragmites australis* patches. Low density patches were not sampled because the focus of aerial treatment was on high density and difficult to access sites.

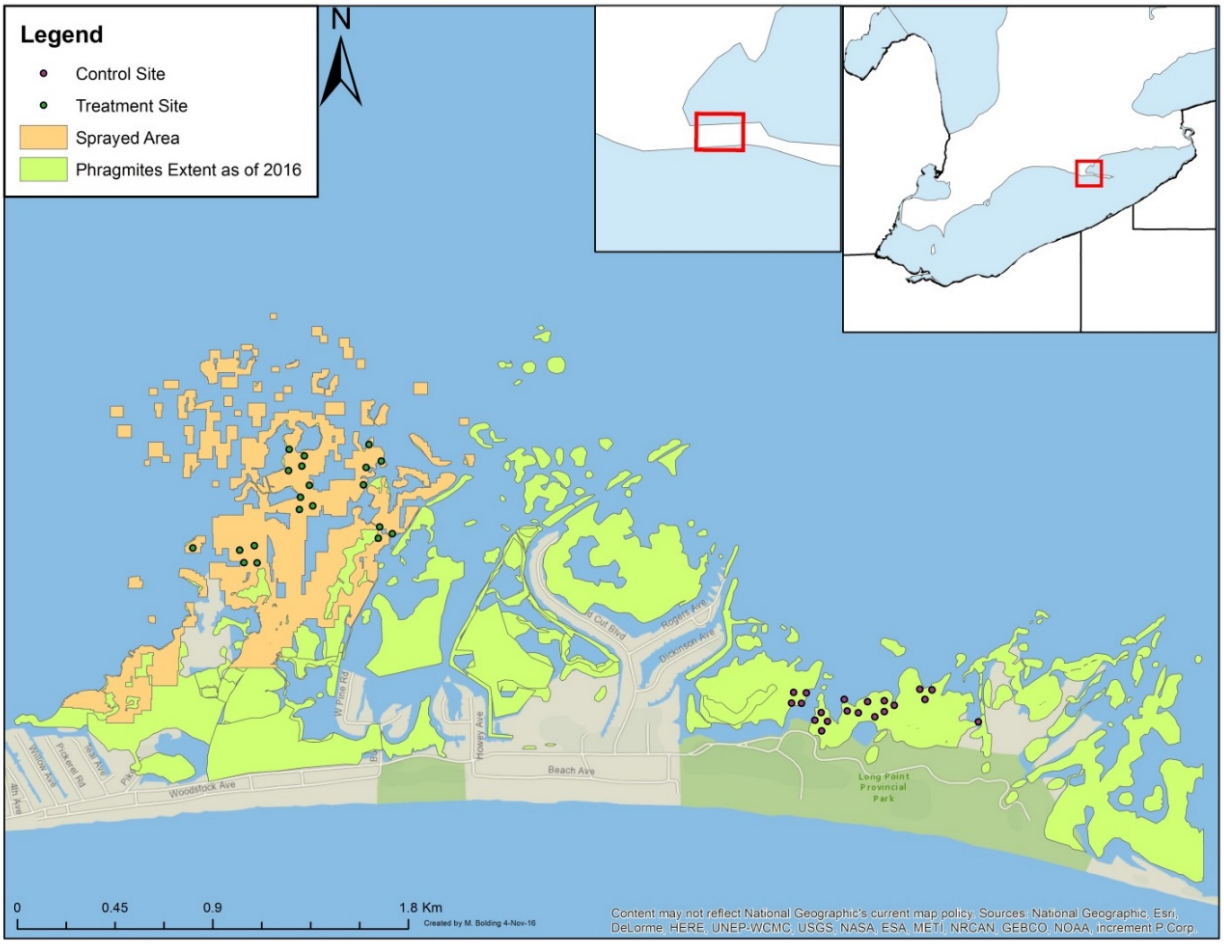

Figure 1. Map illustrating the location of efficacy monitoring sample points and the extent of treated area and the extent of *Phragmites australis* invasion in Crown Marsh in Long Point, Ontario.

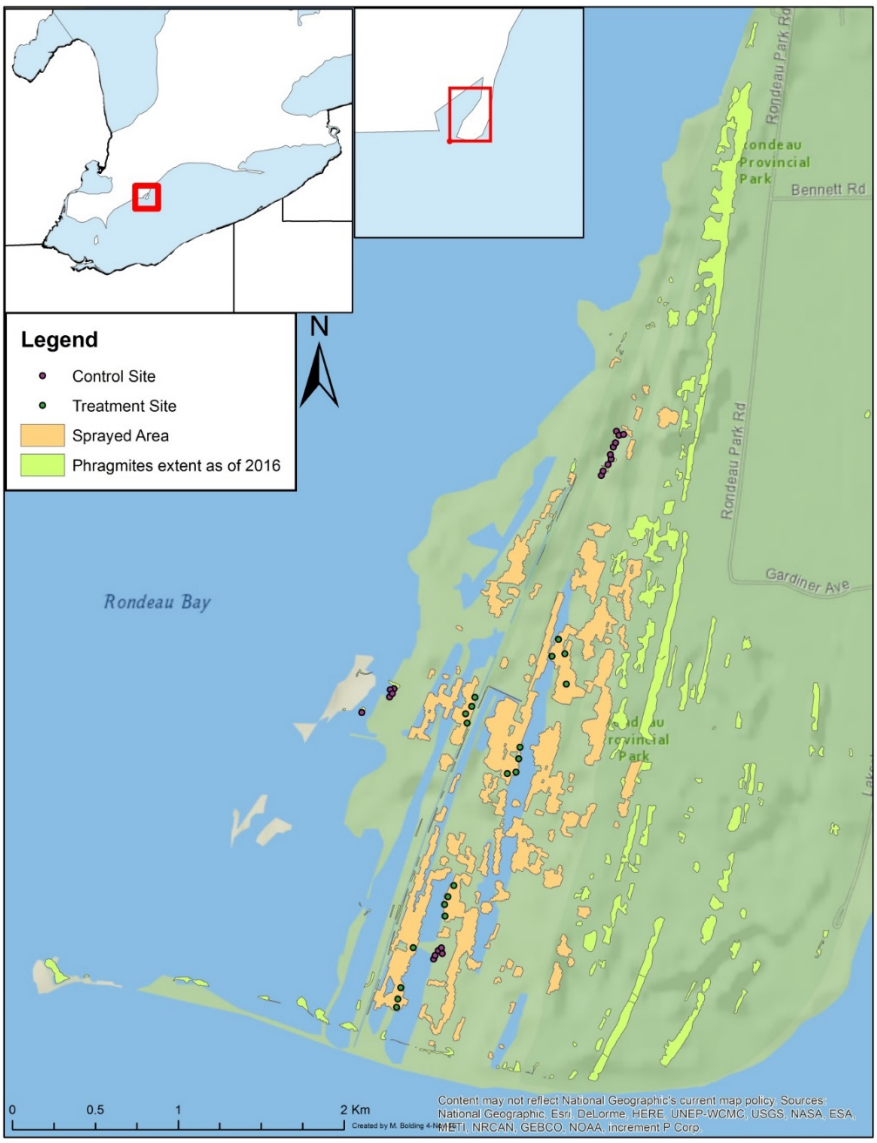

Fig. 2. Map illustrating the location of efficacy monitoring quadrats and the extent of treated area as well as the extent of *Phragmites australis* invasion in Rondeau Provincial Park, Ontario.

At each plot, the following list of measures were taken in 2016, and will be measured again in August of 2017.

At each 1 m^2 plot, we measured the canopy height, the percent of incident light reaching the water or soil, the water depth, the number of *Phragmites australis* flowers, the density of living and dead *Phragmites australis* stems. We also recorded the percent cover of all species, litter and open water present in the 1 m^2 area. Percent covers were considered as a single canopy layer so that maximum cover was 100%. For any species present at less than 1% cover, the cover was recorded as 0.05%, which is considered equivalent to "present," but does not alter total vegetation cover estimates, which ranged

from 65-100%. These data were provided in an excel file named <Deliverable D_EfficiacyData_Rooney2016.xls> that was provided to MNRF in November of 2016.

2017 Sampling

In August 2017, each plot will be revisited to collect the measurements listed in Table 1. This will enable a determination of 1) *Phragmites australis* survival rate at different stem densities; and 2) the *Phragmites australis* survival rate at different water depths. Phragmites survival will be represented by any differences in the number of *Phragmites australis* flowers, the live and/or dead *Phragmites australis* stem density, the % of dead *Phragmites australis* stems, or the % cover of *Phragmites australis*.

Also, we will be able to report on initial recovery of the native vegetation community in treated areas, including any differences in total vegetation cover, diversity (richness, Shannon-Weiner H'), evenness (Simpson's D, Pielou's J), or community composition between the control and treatment plots at each marsh. Covariate measures will include any change in the % litter, % standing dead, % water, % light penetration to water surface, canopy height, or water depth.

Lastly, we will track any secondary invasions into our plots by species like European Frog-bit, Purple Loostrife, Garlic Mustard, and Eurasian Milfoil, all of which have been observed growing in areas invaded by *Phragmites australis*.

Table 1. Measures to be taken at efficacy monitoring plots.

Measure	**Description**	**Units**
Location	GPS coordinates	UTM, NAD 83
Water Depth	Depth of water in centre of plot	m
Canopy Height	Average height of vegetation in plot	m
# Phrag Flowers	The number of flowers on *Phragmites australis* rametes within the 1 m^2 plot	#/m^2
Live Phrag Stem Density	Number of living *Phragmites australis* rametes within the 1 m^2 plot	#/m^2
Dead Phrag Stem Density	Number of standing dead *Phragmites australis* rametes within the 1 m^2 plot	#/m^2
Light intensity at canopy top	Intensity of photosynthetically active radiation (400-700 nm) reaching the top of the canopy in the centre of the plot (i.e. incident light)	umol/m^2/sec
Light intensity at water surface	Intensity of photosynthetically active radiation (400-700 nm) reaching the surface of the water in the centre of the plot	umol/m^2/sec
Total canopy cover	The cumulative percent cover of all vegetation within the 1 m^2 plot	%

Canopy cover of each species	The percent cover of each macrophyte species growing within the 1 m^2 plot	%

Data Interpretation

As described in our 2016 efficacy monitoring plan, we will interpret the data using a BACI approach, comparing the control plots in each marsh with the treatment plots that were paired by water depth. Our baseline assessment in 2016 indicated no systematic differences between control and treatment plots existed prior to the application of herbicide and surfactant in 2016. We will thus contrast the control and treatment plots, using water depth as a covariate and assess any significant differences in the survival of *Phragmites australis*, the recovery of native vegetation, and the presence of undesirable "other" invasive species. Statistical tests will include ANCOVAs and multivariate permutational ANOVAS.

Interpretation of our plot data will be supplemented with analysis of mapping carried out using UAVs by MNRF's Science and Research Branch. This mapping is being undertaken in June/July of 2017 to establish the current distribution of *Phragmites australis* and to delineate areas affected by glyphosate application, evidenced by browning and standing dead vegetation. The delineated areas of glyphosate exposure will be compared spatially to the helicopter reported flight lines and to the proposed treatment polygons to assess the extent of drift or overspray. Further, area-based treatment efficacy will be measured by comparing the current extent of *Phragmites australis* with the 2016 extent of *Phragmites australis* in the area treated in 2016. Contrasting the historic and current distributions of *Phragmites australis* will yield a gross measure of treatment efficacy that will supplement the fine-scale measures of treatment efficacy obtained from our monitoring plots.

Key Constraints

In 2017, several hundred additional ha of *Phragmites australis* is proposed to be treated by combination of helicopter and ground application within our study region. It is critical to the integrity of the efficacy monitoring program that the 2017 treatment or any future applications of glyphosate do not affect our control plots. The GPS coordinates have been supplied to all relevant parties within the Aylmer district MNRF office and the Ontario Parks Rondeau Provincial Park office, and staff have committed that an 80 m buffer will be left around all control plots until 2021 to ensure that these plots are not contaminated and the study design remains intact for the duration of proposed monitoring. This buffer width exceeds the 45 m buffer recommended for ground-based application on the Emergency Use Registration label and we consider it conservative.

Pesticide Fate in the Environment

Objective 2: Fate and Effects of Herbicide and Surfactant

Our main objective is to evaluate whether the application of herbicide to control invasive *Phragmites australis* in wet areas will result in an unacceptable impact to aquatic biota. However, this yields two sub-objectives because the proposed treatment approach in 2017 differs importantly from the approach to herbicide application in 2016 in two ways. First, the majority of treatment in 2016 was by helicopter application, whereas more area will be treated by ground application methods in 2017. Second, in 2016 very little of the proposed treatment area directly touched the Rondeau or Long Point Bays, whereas in 2017 there are several proposed treatment areas that adjoin directly to Long Point Bay. This gives rise to two distinct monitoring objectives:

1) Residue accumulation

We will determine whether the areas treated by the aerial application of herbicide in 2016 have returned to baseline levels in 2017 and whether the application of herbicide elsewhere in the marshes in 2017 causes a detectable accumulation of residues in previously treated locations.

2) Application adjoining Long Point Bay

We will monitor whether the new (2017) application of glyphosate and alcohol ethoxylate to control *Phragmites australis* directly adjoining the Long Point Bay results in exposure to glyphosate, AMPA, or total alcohol ethoxlylates sufficient to put aquatic biota at risk.

To address this second objective, we will adopt a three tiered monitoring approach. First, we will measure glyphosate, its primary breakdown product (AMPA), and total alcohol ethoxylates (active ingredient in the adjuvant) within surface water and bottom sediments within and outside the targeted spray area polygons and compare the pre-treatment concentrations to levels found within 24 hrs and about 30 days following treatment. Note that because ground-based treatment is slower than aerial treatment, we anticipate that treatment may continue for a period of a week or more. We will aim for our post-treatment sampling to occur 30 days after the midpoint of treatment in the relevant marsh. We will compare measured concentrations to available ecotoxicology thresholds to assess the degree of risk that exposure may pose to aquatic biota. This before-after comparison and comparison with published guidelines mirrors the monitoring approach used in 2016.

Second, we will directly assess whether the treatment causes a measureable change in the community composition of benthic macroinvertebrates in stations adjacent to polygons targeted for treatment. Benthic macroinvertebrates are commonly used as sensitive bioindicators in aquatic environments and data collected will follow the standard protocols used by MOECC in assessing the risk contaminants pose to aquatic ecosystems. Because benthic invertebrates are naturally diverse and variable, it is necessary to simultaneously sample an untreated reference area that can be compared to the treatment area to determine whether treatment has an effect on the benthic invertebrate community. The rigorous interpretation of benthic invertebrate samples is not possible without an acceptable reference for comparison.

Third, we will determine whether the herbicide application threatens the wetland food web by measuring the accumulation of glyphosate and AMPA in biofilms, any resulting change in biofilm

composition, and the risk of biofilm contamination to higher trophic levels. Biofilms, comprising attached algae (periphyton), bacteria, fungus and archaea, provide the base of the wetland food web and are critical for the development of amphibians, wetland invertebrate grazers, and many fish species. They also form complex relationships with macrophytes. Thus, the health of wetland biofilms are a keystone indicator of wetland integrity.

Approach

Our two monitoring sub-objectives require different approaches.

1) Residue accumulation

Sampling

To identify whether the concentration of glyphosate, AMPA, or alcohol ethoxylates have returned to baseline following the 2016 treatment, we propose to re-sample bulk water and surface sediment from a sub-set of the stations sampled under the 2016 Monitoring Plan in August, prior to any 2017 treatment taking place. In particular, we would like to re-visit a site at Rondeau within *Phragmites australis* and a site in the Crown Marsh pond where the concentration of contaminants in sediment had not returned to baseline as of the October 2016 sampling period (see monitoring reports F and Fb). The stations we propose be resampled are as follows: 1) the station within *Phragmites australis*, 2) the central pond station in each marsh, 3) the 0 m transect station, 4) the 10 m transect station, and 5) the 50 m transect station at each marsh (see Figures 3 & 4). We do not propose to resample the more distant transect stations (100 m and 150 m) because these stations were not significantly affected by the 2016 treatment.

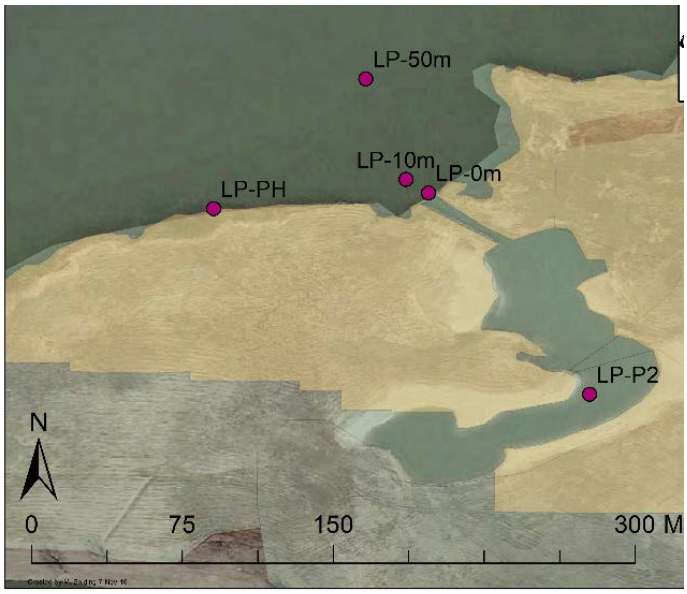

Figure 3. Crown Marsh, Long Point stations that were sampled in 2016, that we propose to resample in 2017. Also depicted is tan shading indicating the extent of the 2016 treatment area. There is no treatment planned within this vicinity in 2017.

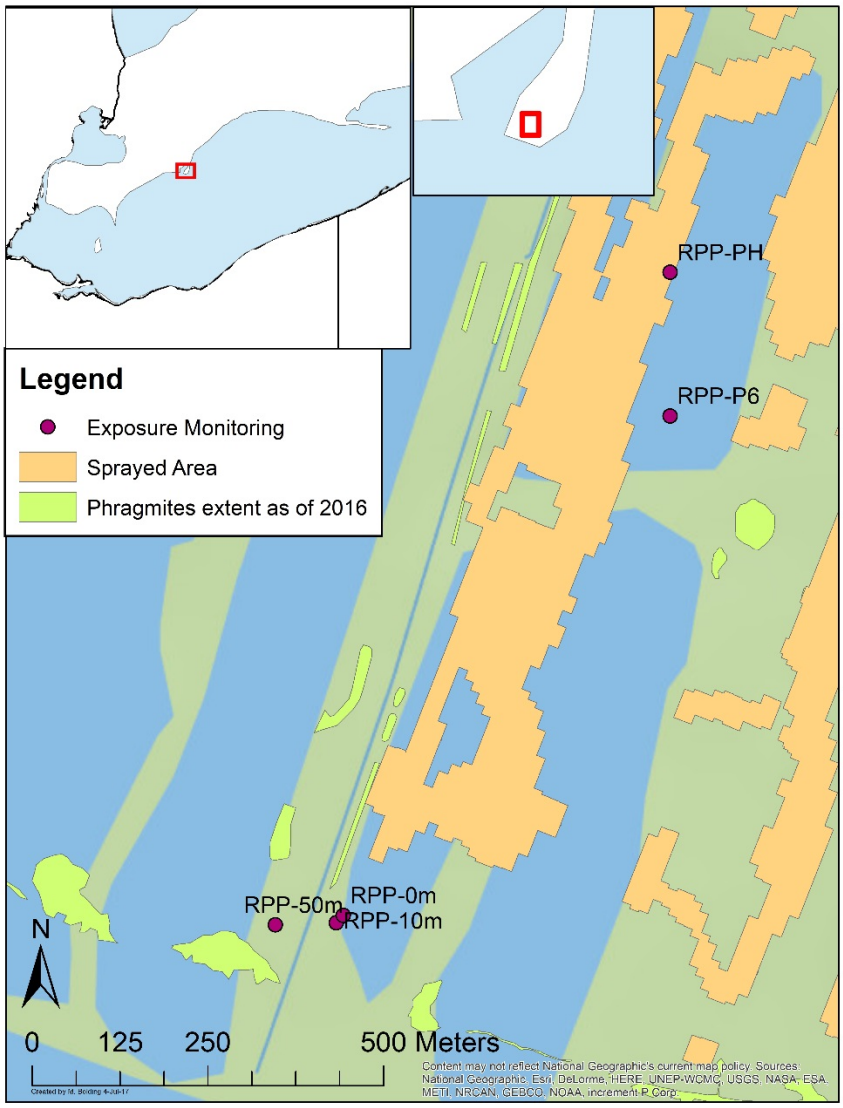

Figure 4. Rondeau Provincial Park stations that were sampled in 2016, that we propose to resample in 2017. Also depicted is shading indicating the 2016 treatment area. Though some treatment will take place in Rondeau Provincial Park in 2017, there is no treatment planned adjacent to these stations in 2017.

Because there is no proposed 2017 application adjacent to these stations, we do not propose to sample them within 24 hrs of application of herbicide within Rondeau or Crown Marsh. However, if we detect glyphosate, AMPA, or alcohol ethoxylate levels above 2016 baseline at these stations during our 2017 baseline sampling, then we propose to resample again 30 days post treatment. Though the literature and our 2016 monitoring results suggest that the dispersal distance of these chemicals is low, resampling 30 days after treatment occurs at distant areas in the marsh will determine whether the application of additional herbicide to Rondeau Provincial Park and Crown Marsh more than 80 m away can result in an increase in glyphosate, AMPA, or alcohol ethoxylates.

Water samples

At each station, we will collect a depth-integrated water sample using plexiglass tube. The sample collection device will be triple rinsed with lake water from the station prior to sample collection. Samples will be transferred into a lab-supplied bottle that has been double rinsed with lake water and stored on ice during transport. Post-collection, samples will be kept in a portable refrigerator at 4 deg. C or stored in a cooler on ice during shipment to the Guelph Agriculture and Food laboratory (AFL). Samples will be delivered to AFL within 48 hrs of collection or frozen until delivery is possible if collection completes on the weekend.

Sediment samples

At each station, on both sampling dates, we will take a Ponar Grab sample of the sediment with the top 10 cm of sediment retained. This sediment depth was selected to agree with historical sampling in Rondeau Provincial Park and the sampling conducted in 2016. The Ponar will be washed between stations with lake water to prevent cross contamination of sediment between stations. Between replicates, spoils will be retained in a bucket on the boat to avoid resuspension of bottom sediments. Spoils will be disposed of near shore, away from the sampling transects. Samples will be collected into containers supplied by AFL and stored in coolers on ice until they can be frozen for transport to AFL within 48 hrs of collection.

Analytical limits

The University of Guelph's AFL lab will carry out all measurements of glyphosate, AMPA and total alcohol ethoxylates in water and sediment samples, with the following limits of detection and limits of quantification. We will be collecting water and sediment samples from 5 stations at each of two marshes on each of two sample collection dates, yielding a total of 20 water and 20 sediment samples for analysis under this monitoring sub-objective.

Table 2. Desired limits of detection and quantification for chemical analytes

Analyte	**Sample Matrix**	**Desired Limit of Detection (ppm)**	**Desired limit of quantification (ppm)**
Glyphosate & AMPA	Water	0.001	0.008
Glyphosate & AMPA	Sediment	0.005	0.020
Total alcohol ethoxylates (including C11EO10AE)	Water	0.03	0.06
Total alcohol ethoxylates (including C11EO10AE)	Sediment	0.3	0.9

Data interpretation

The concentration of glyphosate, AMPA and total alcohol ethoxylates in all water and sediment samples collected in 2017 will be compared to established guidelines, including the Canadian Council of Ministers of the Environment (CCME) guidelines on glyphosate and AMPA, as well as the Human and Environmental Risk Assessment (HERA) guidelines on alcohol ethoxylates. In addition, samples collected

in August 2017, prior to any 2017 application of herbicide in Rondeau or Crown Marsh, will be compared to the 2016 baseline levels to determine whether all concentrations have returned to baseline.

Thresholds for additional work

If analysis of glyphosate, AMPA, and/or alcohol ethoxylates indicates that conditions have not returned to baseline levels within 1 year of the 2016 application, then it raises concerns about the potential for repeated treatments in the marsh to lead to accumulating residues of glyphosate, AMPA or alcohol ethoxylates, especially in the sediment. We anticipate about a 2-3 week turn around on analyses by the AFL lab. If the 2017 baseline samples are above detection limits for these analytes, we will resample the stations in October, about 30 days post herbicide application. If the 2017 treatment results in an increase in contaminants at these sample stations despite no recent application in their vicinity (i.e., within ~ 80 m), we would recommend investigation into the factors that could contribute to elevation in contaminant residues. This might include analysis of sources such as the concentration of contaminants in suspended sediment and shallow ground water, as well as greater spatial representation across the marsh. Such a study would require careful design and inclusion of suitable reference samples to enable interpretation of the resulting data. In the event that the AFL lab is not able to return results within 3 weeks of submission of the 2017 baseline samples, we will collect samples in October from all stations as a precaution and hold these until the 2017 baseline results are released.

2) Application adjoining Long Point Bay

Station distribution

Because several of the 2017 proposed treatment areas directly adjoin Long Point Bay, we propose a modified sampling approach from what was carried out in 2016. No such treatment is proposed for Rondeau, and so no additional sampling at Rondeau is deemed necessary. Rather than focus on pond outlets into the Bay, we propose to establish transects with stations situated 1) in *Phragmites australis* at the edge of the open water, 2) in the open water adjacent to a treated *Phragmites australis* polygon, 3) 10 m away, 4) 25 m away, 5) 50 m away, and 6) 100 m away from the treatment polygon boundary (e.g., Figure 5).

To provide a reference to which to compare the treated stations, we propose that these transects be deployed as pairs, with one transect originating from a patch of *Phragmites australis* that will be treated with herbicide in 2017 and the other member of the pair serving as a local reference transect. References will be established such that they are within 2 km but more than 1 km away from the treatment transect and are positioned in an area of similar exposure as the treatment transect, yet they will be in an area where no treatment is proposed to occur in 2017. Sampling a reference transect is vital to any analysis of benthic invertebrate samples, as without a reference for comparison the potential effect of herbicide exposure on the community composition, diversity and abundance of benthic macroinvertebrates cannot be interpreted. To relate the benthic invertebrate data to ambient levels of glyphosate, AMPA, and alcohol ethoxylates, these must be measured at every station, including the reference transect stations. Thus, water and sediment samples will also be collected and analysed from the treatment and control transect stations.

Figure 5. Example of transect with stations ranging from the edge of the proposed treatment polygon out 100 m into the Long Point Bay. This transect is positioned in Crown Marsh. Note that an additional station (green symbol) will be sampled for water and sediment chemistry within the proposed treatment area; however, we will not be able to collect a benthic invertebrate sample from this station due to the dense thatch and high stem density of *Phragmites australis*, which prevents to the correct operation of the sampler. Ponar samples for benthic invertebrates will be restricted to the stations situated in the Bay (i.e. 0 m to 100 m).

Based on the distribution of proposed treatment areas, we plan to sample three pairs of transects (Figure 6). One pair will bracket Big Creek (a moderate exposure level), another will be situated near Crown Marsh and the Long Point Provincial Park (low exposure), and the third pair will be positioned on Turkey Point (high exposure). These three locations all represent different exposures, hydrology, and likely substrate, thus sampling at all three locations will provide good representation of conditions across the Long Point Bay. The pairs of transects from the different locations in Long Point Bay are depicted in Figures 7, 8 and 9.

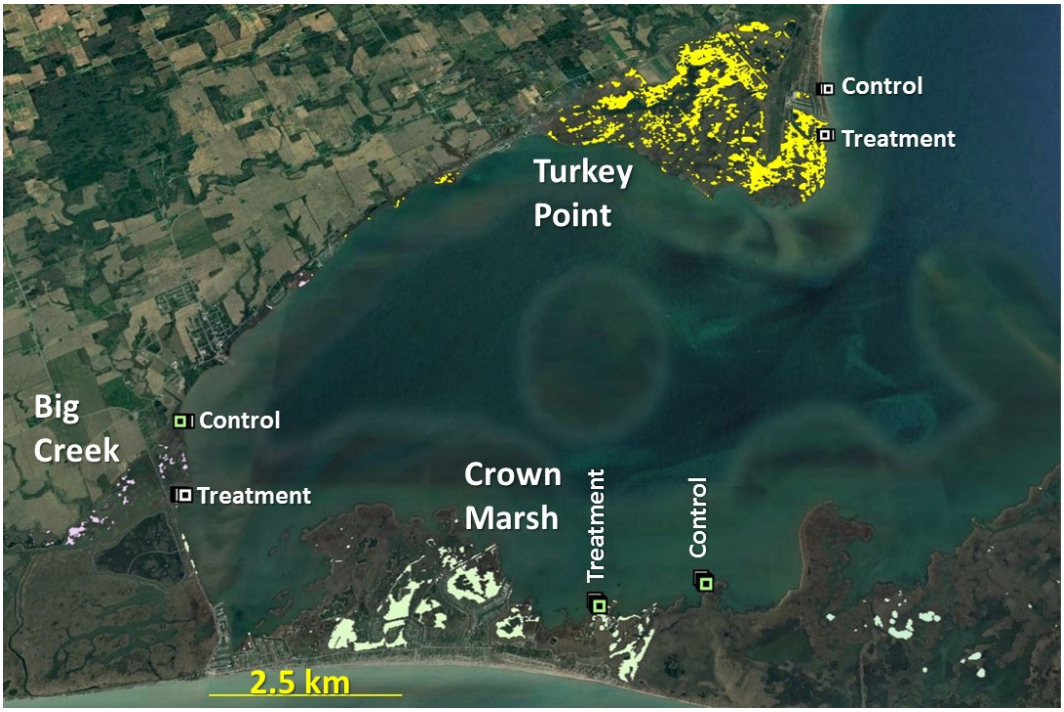

Figure 6. Location of transect pairs in Long Point Bay. Note that pairs include one treatment and one control or reference transect. The within-pair transects are separated by 1-2 km, whereas the pairs themselves are separated by at least 5 km. Polygons indicate proposed treatment areas.

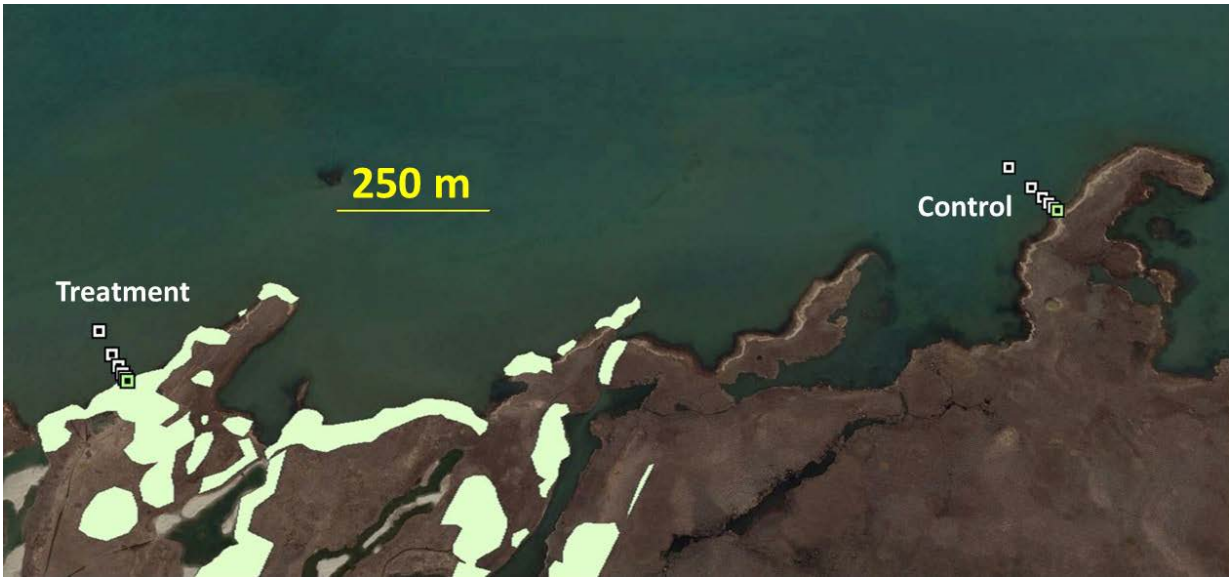

Figure 7. Treatment and control transect locations in Crown Marsh. Polygons indicate proposed treatment areas.

Figure 8. Treatment and control transect locations in Big Creek. Polygons indicate proposed treatment areas.

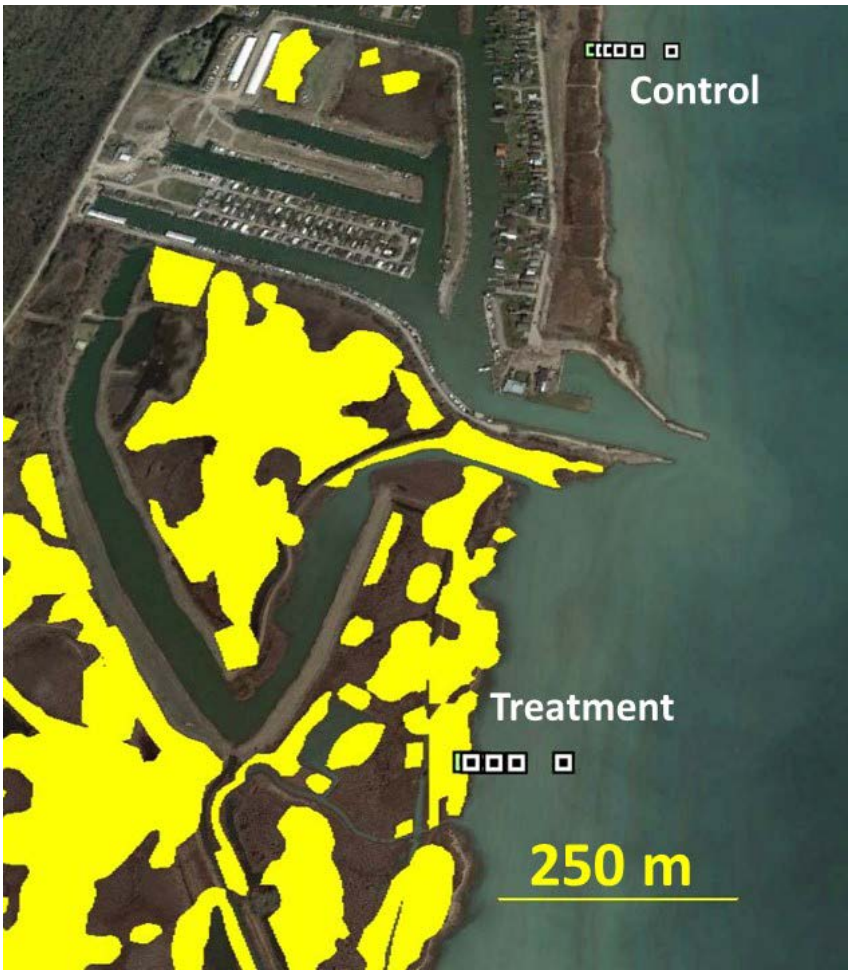

Figure 9. Treatment and control transect locations in Turkey Point. Polygons indicate proposed treatment areas. Note that sampling the treatment stations will require land owner permission, as this land is privately owned.

All transect stations at the six transects will be sampled for water and sediment, as was done in 2016. However, benthos will only be sampled from the pair of transects in Turkey Point and the pair in Crown Marsh. The Big Creek transects will not be sampled for benthos because the creek discharges water from an agricultural basin where glyphosate and other pesticides and chemical fertilizers have been applied (Fig. 10). Thus, there is no suitable location for a true control transect to be established and comparisons between the benthic invertebrate communities in the treatment and control stations could not be attributed to any one cause.

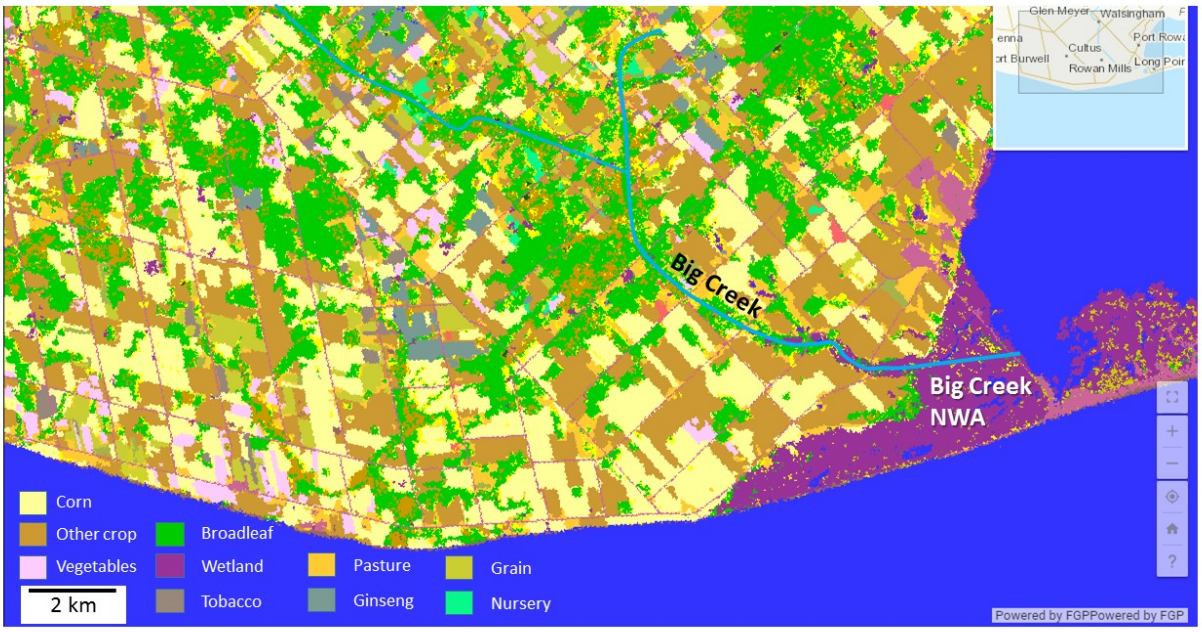

Figure 10. Crop inventory data from Agriculture Agri-Food Canada's 2015 inventory, indicating land cover within the Big Creek Watershed. Note the extensive corn, grain and other crop cover, as well as large patches of tobacco and ginseng. These crops are commonly treated with glyphosate herbicide.

Water and sediment sampling

Mirroring the work carried out in 2016, we will collect water and sediment samples for analysis by Guelph's Agriculture and Food Lab (AFL) prior to any 2017 application of herbicide, within 24 hrs of herbicide application at the "treatment" transect stations, and 30 days post treatment. Sampling will be undertaken by two teams of two, one in a large Jon Boat and another in a 16' Legend. One team will collect samples from the control transect while the other team collects from the treatment transect. This will reduce the risk of contaminating control samples with glyphosate or alcohol ethoxylates from previously exposed supplies or equipment.

Water will be collected at each station as a depth integrated water sample using a plexiglass sample tube triple-rinsed with lake water and collected into a lab-supplied bottle that we first double-rinse with lake water.

At each station, we will also collect a bulk sediment sample using a clean Ponar Grab sampler that is triple-rinsed with lake water. The top 10 cm of collected sediment will be transferred into a lab-supplied sample jar that is first double-rinsed with lake water. This mirrors sampling completed in 2016 and the sampling to be undertaken as part of monitoring for potential residue accumulation.

All samples will be kept refrigerated or in a cooler on ice until they can be delivered to Guelph's Agriculture and Food Lab (AFL). Desired limits of detection and quantification are the same as those reported in Table 2. The water and sediment samples will be delivered to AFL within 48 hours of collection or if not possible, they will be frozen until they can be delivered.

Water and sediment samples will be collected from all transect stations, including the three stations directly in stands of *Phragmites australis* that will be treated with herbicide in 2017. The total number of sampling stations will be 36. Thus, the total number of transect station samples delivered to AFL for this monitoring sub-objective will be 108 water and 108 sediment.

Benthic invertebrate sampling

A new addition to the 2017 monitoring plan is the collection of benthic invertebrate samples from the Crown marsh and Turkey Point transect stations before, within 24 hrs of, and about 30 days after herbicide treatment. At each station we will collect three replicate benthic invertebrate samples using a Wildco stainless steel Petite Ponar Grab sampler that is triple rinsed with lake water between stations. The Ponar will be emptied into a clean bucket and the sides will be rinsed down with squirt bottles filled with sieved (500 um mesh) lake water, to avoid introducing additional organisms or losing organisms that adhere to the sides of the Ponar. The buckets will be sealed and transported back to the marina when sampling is completed. At the marina, samples will be rinsed using sieved lake water from the buckets into sieve bags (also 500 um mesh) provided by MOECC. The samples within the bags will be gently washed to remove fine particles, with care to avoid destroying invertebrate tissues. The residues will be rinsed into 500 mL sample jars using 10% buffered formaldehyde, by volume.

The decision of which benthos samples to analyse from the total number collected follows a logic tree. Samples to be analyzed will be sorted and the macroinvertebrates within them will be enumerated and identified to the lowest practical taxonomic level by Dr. Jan Ciborowski's research lab at the University of Windsor. Initially, only samples from the 0 m transect stations (3 replicates x 4 stations x 3 collection dates = 36 samples) will be analyzed. The Rooney Lab will archive the 144 remaining benthic invertebrate samples from the 10, 25, 50, and 100 m stations, and MNRF can have them sorted and identified if the glyphosate, AMPA, or alcohol ethoxylate water and/or sediment concentrations exceed the thresholds for concern established by the CCME and HERA.

Risks to biofilms and the food web

In discussion with MOECC , there was interest in assessing the potential for herbicide treatment of *Phragmites australis* to negatively affect microbial communities and the wetland food web. The greatest density of microscopic organisms in wetlands is found in biofilms that cover all aquatic surfaces including sediment and the submerged stems and leaves of plants. These biofilms form the base of the wetland food chain and include a significant component of "attached algae." Algae are known to be highly sensitive to glyphosate and are valuable bioindicators in wetland systems. Our pilot work on biofilms in 2016 determined that the concentration of glyphosate and AMPA present in the biofilms growing on artificial substrates exceeded the concentrations found in the surrounding water and sediment and concentrations remained elevated above baseline levels one month after herbicide exposure. A disruption of biofilm ecology may alter the community composition of biofilms, affecting not only eukaryotic algae but also bacteria and archaea. Further, it could result in bottom-up effects on the wetland food web by altering forage availability or quality for grazers like tadpoles, snails, and some fish.

To assess the risk that herbicide-based control of invasive *Phragmites australis* might pose to biofilms and the wetland food web, we will employ a BACI design to collect biofilms before and after application of the herbicide at a pond in the 2017 treatment area and simultaneously at a control pond that will not be exposed to glyphosate application and at a pond that was exposed to glyphosate during the 2016

herbicide application. We will also establish stations for biofilm collection at the 0m transect stations where benthic invertebrate samples will be taken and analyzed in Big Creek and Crown Marsh. The Turkey Point transects were deemed too exposed for biofilm collection, and so no biofilm will be collected from the Turkey Point transects.

Biofilms will be collected using artificial substrates. These are inert plexiglass plates measuring 17" by 8" and suspended within 10 cm of the water surface by gill net floats secured to U-poles as anchor points (Figure 11). This provides a standardized and ideal habitat for biofilms to form to maximize comparability for before-and-after sample comparisons as well as for control-and-treatment station comparisons. One month is given for plates to acclimate to avoid confounding successional effects with treatment effects. The use of a reference location also helps compensate for any temporal dynamics in biofilm communities.

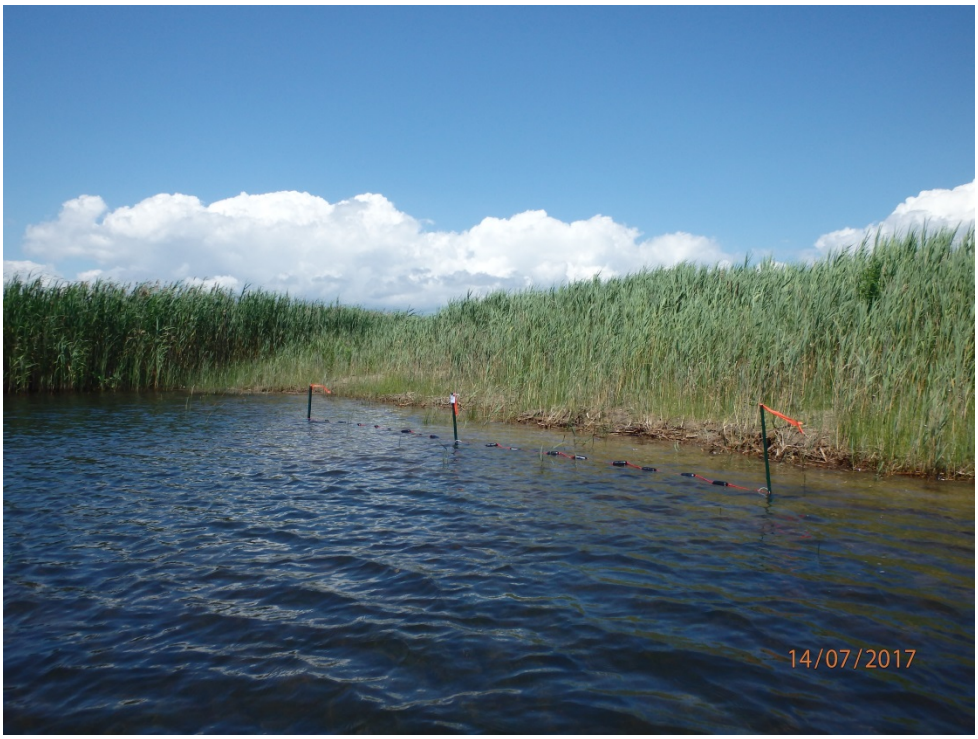

Figure 11. A photograph of one of the biofilm sampling stations at the 0 m transect station at the Big Creek treatment transect. Invasive *Phragmites australis* is evident in the background. The depicted samplers were installed on July 14, 2017 (see date stamp on the photo).

At one 2017 treatment pond, one 2016 treatment pond and one control pond, we established 5 stations between 50 cm and 1 m deep (Figure 12). As mentioned, stations were also established at the 0 m stations for the Big Creek and Crown Marsh transects. By July 15, 2017, all station were populated with artificial substrate plates: 8 per station in the selected ponds and 5 per station at the 0m transect locations. These will be allowed to equilibrate with the lake water for one month prior to the collection of baseline plates (2 per station) on the 25 of August. An additional four plates will be harvested within 24 hrs of the application of herbicide to the pond to be treated in 2017 (aka Granger Pond). In Crown Marsh, we anticipate this occurring around September 10, whereas at Big Creek this is likely not to take place until September 18, based on the current ground application schedule. A third set of two plates

will be collected from each station, 30 days following herbicide application. On every collection date, a water sample will also be collected from stations 1 and 3 (n = 2 stations x 3 ponds x 3 collection dates = 18). These water samples will be collected following the protocol for water sampling described above and analysed by Guelph's AFL lab for glyphosate and AMPA to represent the ambient conditions under which biofilms are growing.

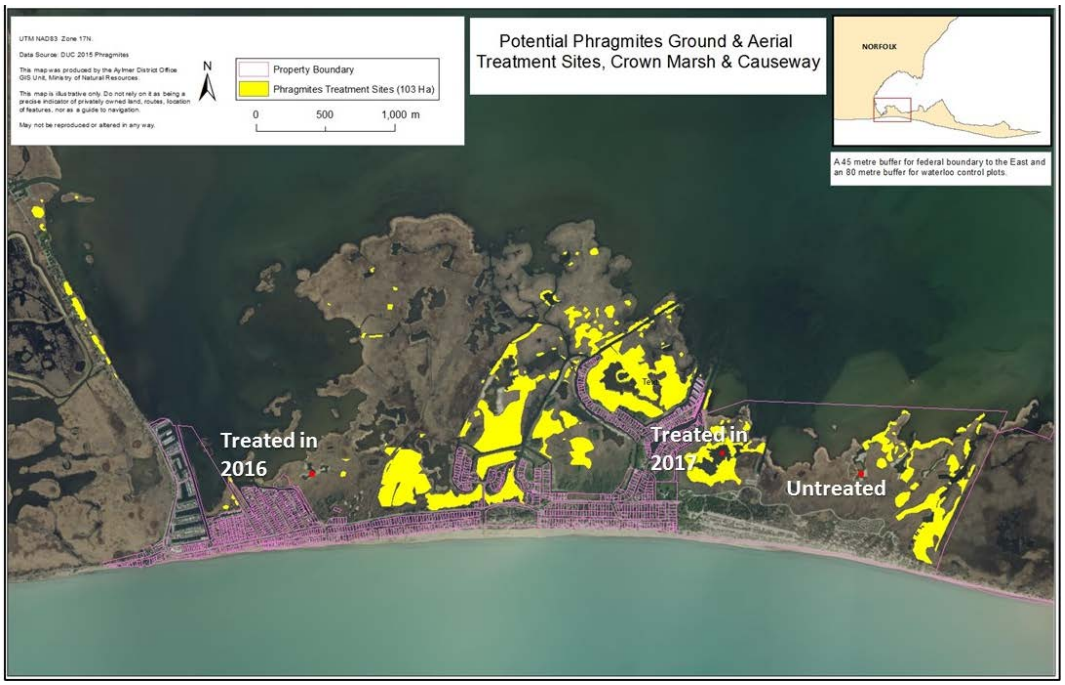

Figure 12. Location of three ponds in which of each, five stations will be erected where artificial substrates will be deployed for sampling biofilms. The red dots indicate the location of the ponds, the yellow polygons indicate proposed treatment areas for 2017.

The plates will be collected and stored in sterile zipper-seal bags and kept in coolers during transport back to the lab. In the lab, biofilms will be harvested from artificial substrates via scraping with clean implements that are triple-rinsed in Milli-Q (distilled and deionized) water between samples. Milli-Q may also be used to rinse the plates, zipper seal bags and scraping implements to ensure a quantitative transfer of biofilm from the plates to the sample containers.

The harvested biofilm from 2 plates collected from each station on each sampling occasion (2 plates from each of 5 stations per pond) will be sequentially composited, homogenized and sub-sampled, as indicated in Figure 13.

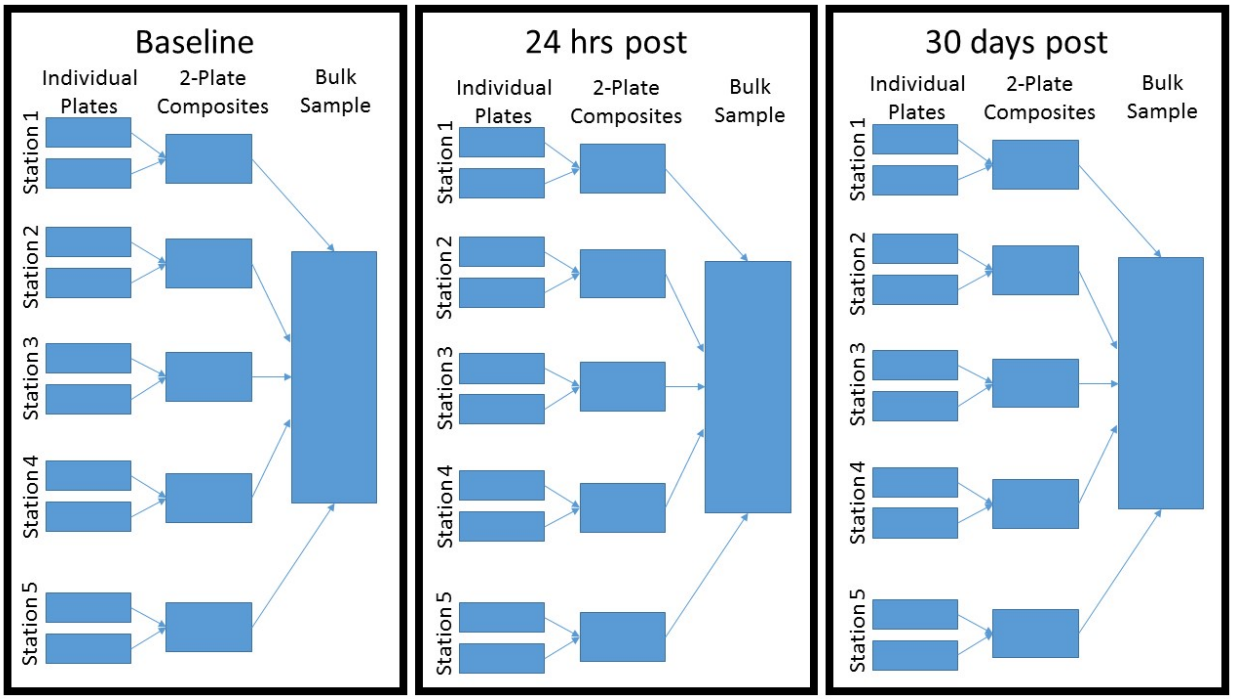

Figure 13. This schematic illustrates how the biofilm collected from artificial substrates within a single pond will be composited. Two individual plates will be collected from each of five stations in each pond on each collection date. The two plates will be composited first, and then a sub-sample will be collected for DNA analysis. Then the 2-plate composites from each station will be composited to yield a single bulk sample per pond from each collection date. The bulk sample will be subsampled for analysis of glyphosate and AMPA, and the remainder will be frozen for use in a tadpole feeding trial to be carried out in the summer of 2018.

A sub-sample of each 2-plate composite will be collected for DNA extraction and analysis with a 16S extraction for bacteria and archaea and an 18S extraction for algae (n = 3 sample dates x 5 stations x 3 ponds). All plates from each collection date at the transect 0m stations will be composited and also analyzed for DNA (3 collection dates x 1 station x 4 transects). This will generate a total of 57 biofilm samples for DNA analysis. Pilot tests carried out by the company Metagenom Bio Inc. (based at the University of Waterloo) have established a successful extraction and amplification technique for these biofilm samples already. These analyses will identify the species of bacteria, archaea, and algae present in each composite sample and will enable us to evaluate whether treatment has resulted in any change in the community composition and diversity of these microscopic organisms.

The remaining biofilm material from pond stations will be further composited to produce a single homogenous bulk sample from each pond on each collection date (n = 9 from ponds plus n = 12 from transect 0 m stations). A sub-sample of each bulk sample will be freeze dried to yield a minimum of 0.1 g dry weight. These samples will be transported frozen to Guelph's AFL for analysis of glyphosate, AMPA and caloric content. Too great a sample volume is required to measure the concentration of alcohol ethoxylates in biofilm material, based on pilot work in 2016, so only glyphosate and AMPA will be measured. This will allow us to test whether there is a difference in contaminant load among the bulk samples.

Another sub-sample of each bulk sample from the ponds (n =9) will be analyzed for caloric content by bomb calorimeter. This will yield insight into the nutritional value of different biofilm samples.

The remainder of the bulk samples from the pond stations will be divided into large Whilrpak bags and frozen. In summer 2018, these will then be used in an amphibian-based ecotoxicology experiment planned to be conducted in Peterborough. In this experiment, nine sets of tadpoles will be created from a single batch of wild-collected eggs. Each set will be fed a diet of biofilm from one of the pond x collection date combinations for 14 days. Mortality, weight change, behavior, and developmental rate will be monitored to serve as study end points. Any differences among tadpoles fed diets from the three different ponds x 3 different collection dates could indicate a potential food web effect of the impact of treatment on biofilms. This will be related to the community composition, measure of contaminants and nutritional quality in the bulk samples from different ponds or collection dates.

Thresholds for additional work

As discussed, the benthic invertebrate Ponar grab samples from the 10, 25, 50 and 100 m transect stations in Turkey Point and Crown Marsh will be archived and sent for enumeration and identification only if thresholds of concern are exceeded in water and sediment samples collected from the associated stations. Water and sediment samples from all stations will be analyzed for glyphosate, AMPA, and alcohol ethoxylate and compared to thresholds for concern established by the CCME and HERA. Unless these guidelines are exceeded, only the three replicate samples from the 0 m stations at each transect on each sampling date will be analysed. This will yield a total of 36 samples for immediate analysis (3 replicates x 4 transects x 3 collection dates), with another 144 samples archived for potential future analysis.

Data interpretation

Water, sediment and benthic invertebrate samples collected pre-application of herbicide will be compared between the equivalent control and treatment stations to ensure that the control stations serve as suitable references. This is especially important with the benthic invertebrates. The values pre-application will also be compared with the values measured from the same station post-application to assess whether any change has occurred within each station. Water and sediment concentrations will also be compared to published thresholds that indicate concentrations of concern for the protection of aquatic biota in freshwater. If these thresholds are exceeded, it indicates that the application of herbicide may have endangered the local biota. Benthic invertebrates will be compared between equivalent stations at each control and treatment transect pair to assess whether an impact from herbicide application has occurred. If any deviations between control and treatment transects have not disappeared within 30 days of treatment, it would indicate that the impact of herbicide treatment is more persistent.

Biofilm community composition and diversity will be compared among ponds on each collection date. If communities from the three ponds are similar at baseline sampling, but they diverge following herbicide application, that will indicate an effect of herbicide on the biofilm community. If communities re-converge within 30 days of herbicide application, we will conclude that any effects were short-lived. Similarly, any differences in tadpole measurements in the group fed the biofilms collected from the treatment ponds and the control pond would indicate that the treatment may impact the wetland food web directly or indirectly. We will be able to use the measurements of glyphosate, AMPA, and caloric

content of the biofilm material from each bulk sample to help infer the mechanism by which the application of herbicide caused any observed effect on biofilms and their dietary value.

Appendix B:

2017 monitoring plan for effects of the control activity on fish and fish habitat (objective 2)

The 2017 Phragmites Control Monitoring Plan pertaining to the effects of the control activity on fish and fish habitat.

Effects on Fish and Fish Habitat

This monitoring will address monitoring objective #3 (Monitor effects of the control activity on fish and fish habitat). The protocols for this monitoring are outlined below.

No negative impacts to fish or fish habitat are expected to occur as a result of the herbicide application to control Phragmites; indeed, it is expected that Phragmites control will ultimately result in beneficial improvements to aquatic values for both locations. In 2016, water samples taken by the University of Waterloo immediately after herbicide treatment (24 hours), and one month post treatment at both Rondeau and Long Point were all well below the Canadian Council of Ministers of the Environment (CCME) long-term exposure threshold for the protection of aquatic life.

Herbicide application is intended to be applied only to dense stands of Phragmites, not to open water; and the aerial treatment will be undertaken in a manner to avoid the potential for drift (see objective 2 regarding monitoring that will occur to assess the occurrence of impacts to non-target vegetation).

However, both Rondeau Provincial Park and Long Point Crown Marsh will be monitored for any incidental observations of impacts to fish, in combination with other monitoring that is already occurring at the two sites. It is proposed that monitoring intervals will occur prior to treatment, 24 hours post-treatment and 2-3 days post-treatment.

This will also include before and after control photo-documentation of the treatment sites to document physical changes in Phragmites stands and plant breakdown.

Similar to 2016, a Before-After Control Impact (BACI) monitoring design will also be specifically applied to the Long Point Crown Marsh, to assess any fish mortality (none anticipated) in ponds adjacent to treated sites vs. untreated sites. These ponds will be monitored prior to treatment, 24 hours post-treatment, and two-three days post-treatment.

Effects on Fish and Fish Habitat Monitoring Plan

Proposed Long Point Aquatic Values Monitoring Plan

Although no fish mortality is anticipated, a BACI monitoring design will be applied at the Crown Marsh in Long Point, to assess whether herbicide application to control the invasive Phragmites increased fish mortality rates. The Crown Marsh site was selected for the most thorough monitoring because:

- aerial herbicide application is planned for Phragmites stands that surround open water communities/ponds that are both formally connected to Lake Erie and some that are not connected; the latter are considered important to include in monitoring because they may be more sensitive to control activity due to the fact that they are smaller closed systems; multiple ponds are found throughout Crown Marsh, inside and outside of the herbicide application area. Therefore, multiple control and impact sites can be surveyed.
- access to ponds in Crown Marsh is good, making the application of BACI design practical.
- Four wetland fish species-at-risk - Grass Pickerel, Lake Chubsucker, Pugnose Shiner and Warmouth - have been collected from constructed ponds in Long Point.

It is planned that two control ponds will be surveyed and three ponds, at least one of which will not be formally connected, adjacent to herbicide application will be surveyed. Refer to Figure 1 below for a map of ponds selected for survey. Inclusion of ponds in the monitoring study will be determined based on whether sites that can be physically accessed. Extensive, dense stands of Phragmites can prevent access on foot to ponds.

Each pond will be surveyed prior to herbicide application; 24 hours post application, and two-three days post-treatment.

At each pond, single-day fish kill surveys will be completed. A single-day survey will consist of visual surveys of 20 randomly-placed, shoreline transects. Each transect will be two metres wide and 10 metres long.

Field staff will walk slowly along each transect to document the presence of any counting the number of dead fish observed. Polarized sunglasses and/or underwater viewers will be used to improve detection. In addition to counts, observations of abnormal fish swimming behavior will be noted. Time spent surveying each transect will be recorded.

If encountered along individual transects, a subsample of dead fish will be kept for species identification in the lab. Collected fish will represent different fish families encountered. Fishes will be stored in zip-lock bags and frozen. Each bag will be labelled (pond, date, transect).

Monitoring surveys will be led by:

Lead: Steve Rowswell, Integrated Resource Management Technical Specialist, MNRF
Field Support: 4 or 5 person crew consisting of MNRF Management Biologists and Technicians

Proposed Rondeau Provincial Park Aquatic Values Monitoring Plan

Lead: Jenni Kaija, Assistant Ecologist, Ontario Parks
Field Support: Ontario Parks' staff

Protocol:
Four 200 metre transects will be established through Rondeau Provincial Park. These transects will cover areas receiving treatment with herbicide and areas that will not receive treatment. Following these transects, staff will paddle or walk and observe 1m on each side of the line for dead fish.

Transects will cover both open water areas and small ponds, on both sides of the Marsh Trail.

If dead fish are encountered, the GPS location will be recorded and the fish will be collected and labelled. In addition, observations of abnormal behaviour will be noted.

Transects will be monitored on three occasions:

- Before treatment
- 24 hours after treatment
- 3 days after treatment

Herbicide Treatment in Other areas that include Private Lands in Long Point Region

Herbicide application is proposed to expand into areas of Lower Big Creek and wetland complexes of Turkey Point in 2017. These areas present logistical challenges for

MNRF staff to conduct thorough fish monitoring surveys. High sediment load and deep organic mass make visibility and travel through the Lower Big Creek area a challenge. Observation of fish, even if present would be difficult and time consuming. Additionally, the private lands of Turkey Point will have very limited access. It is proposed that staff resources and monitoring are focused on the Long Point Crown Marsh and Rondeau Provincial Park BACI design.

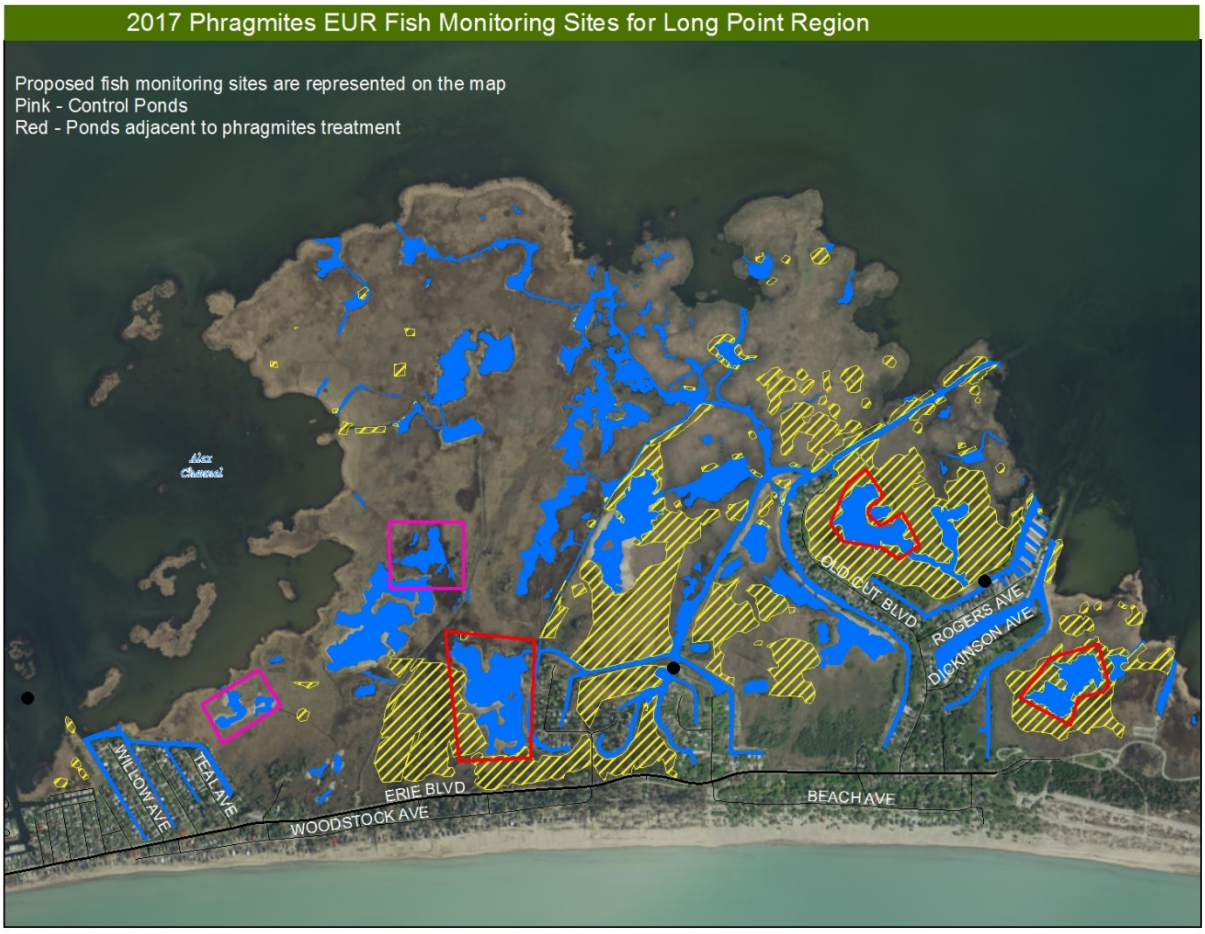

Figure 1: Map showing proposed phragmites treatment polygons in the LPCM with a depiction of ponds where fish monitoring will take place. Control sites are outlined in pink, whereas treatment sites are outlined in red.

Figure 2: Map of Rondeau Provincial Park with proposed phragmites treatment polygons and depiction of fish monitoring transects.

Appendix C:

2017 monitoring plan for glyphosate concentrations in surface water samples adjacent to community of Long Point, Turkey Point and residences near the outlet of Big Creek (objective 5)

2017 Monitoring Plan for Glyphosate Concentrations in Surface Water Samples adjacent to community of Long Point, Turkey Point and residences near the outlet of Big Creek.

Water sampling adjacent to community of Long Point, Turkey Point and residences near mouth of Big Creek

This monitoring will address monitoring objective #5 (Monitor glyphosate concentrations in surface water samples adjacent to the community drinking water intakes that are near the herbicide application areas at Long Point, Turkey Point and the mouth of Big Creek). Similar monitoring occurred during the 2016 Pilot Project and all samples collected found glyphosate levels to be below the Ontario Drinking Water Quality Standard of 0.028 mg/L. Additional sampling is being proposed in 2017 due to the expansion of herbicide application at Lower Big Creek and Turkey Point. This year's sampling plan will provide assurances that plans are in place to notify and respond to the Ministry of Environment and Climate Change as well as the Haldimand-Norfolk Health Unit. A total of 6 sampling sites will be monitored. Two of these sites are at centralized locations adjacent to herbicide application areas in the Long Point Crown Marsh, three more sites are adjacent to treatment areas at Lower Big Creek and the Long Point Causeway, and one site is adjacent to treatment areas at Turkey Point. Please refer to mapping below for accurate depictions of sample sites.

Turkey Point

Background

A privately-owned intake, Lakeview Water Systems which supplies the residents of the community of Turkey Point with drinking water, is located offshore approximately 1500' from 10 Ordnance Avenue at a depth of approximately 10' – 12' below the surface of Lake Erie and 5' above the lakebed.. The Macdonald Turkey Point Marina uses a surface water system located at their boat ramp inside the marina channel system. A barrier berm of vegetated dry land 30m wide separates the treatment area from the Macdonald Turkey Point Marina property. All treatment within 125m of the Marina property line will be done using ground equipment to maximize application accuracy and minimize opportunity for herbicide drift. Discussions with the operators of Lakeview Water Systems and Macdonald Turkey Point Marina as well as the Haldimand-Norfolk

Health Unit have been held to ensure awareness and knowledge of the pilot project and to discuss protection of water system quality.

Sampling methodology

Water samples will be collected adjacent to treated areas which are located on the east side of the peninsula of Turkey Point only, due to the proximity to drinking water sources. Water samples are not proposed for areas west and north of the peninsula of Turkey Point due to the long distance to water sources, predominant current flow in Long Point bay and physical barrier of land between the treatment areas and any water intakes, resulting in a very low risk to drinking water quality.

Water samples will be collected approximately 1500' offshore at a depth of 10' – 12' and 5' above the lakebed to emulate the location and depth of Lakeview water systems intake (See Figure 2). The initial sample location will be due south from the entrance to the channel leading to MacDonald Turkey Point Marina. A GPS confirmation of the sample location will be taken at the time of sampling. The samples will be analysed within a 24 hour turn-around time, for the presence of glyphosate, by a laboratory that has received Canadian Association for Laboratory Accreditation (CALA), and holds a Ministry of Environment and Climate Change license for the glyphosate analysis in drinking water.

The laboratory will have a method of minimum detection limit of 0.005 mg/L for glyphosate which is more sensitive than the Ontario Drinking Water Quality Standard (ODWQS) of 0.028 mg/L. The purpose of this sampling is to confirm that glyphosate concentrations, post spraying, in the surface waters adjacent to the water intakes are less than the Ontario Drinking Water Standard (ODWQS) for glyphosate. The results will be immediately reported to the Ministry of Environment and Climate Change and the Haldimand Norfolk Health Unit.

A map of the proposed sample area is below (see Figure 1). Baseline samples will be collected at the proposed sample location (LV 1) prior to the initial spray date within the Turkey Point treatment areas, located east of the peninsula of Turkey Point. Post-treatment samples will begin at LV 1 within 12 hours and again at 24 hours after treatment, continuing until a downward trend in the glyphosate levels is confirmed or a return to baseline levels is reached (see Table 1). LV 1 is strategically placed in between the treatment areas and LV 2 (the water intake) to identify any potential herbicide in transit after treatment. Due to likeness of LV 1 and LV 2 in terms of depth

and distance from shore, as well as close proximity, it is proposed that a baseline sample is not needed at LV 2.

If necessary, the Ministry of Natural Resources and Forestry (MNRF) will continue sampling at 24 hour intervals post-treatment, to demonstrate a downward trend and that the levels are below the ODWQS. If at any interval, the glyphosate levels exceed the ODWQS, MNRF will conduct the 48 hour sample at the water intake for Lakeview Water Systems to confirm that levels entering the water system remain below the ODWQS. Arrangements will be made with the Lakeview Water Systems Operator to take a treated water sample simultaneously and if the raw water sample exceeds the ODWQS, the treated sample will be immediately analyzed by a Laboratory that is appropriately Licenced and Accredited to test Drinking Water Samples. Should this level exceed the ODWQS, the Medical Officer of Health (MOH) and the MOECC will be notified and consulted, a 72 hour raw sample and a treated water sample will be taken and next steps will be determined in consultation with the MOH. If directed by the MOH, the treated water sample will be submitted to a lab that is appropriately licensed and accredited to test drinking water.

The Lakeview Water System operator has confirmed the ability to fill their reservoir by truck in the event that contaminated water is suspected in the system. This will allow for the residents of Turkey Point to have a continuous supply of fresh drinking water should it be needed. The MNRF is prepared to truck this water in, if needed, to ensure potable water is available. A list of approved water suppliers has been provided by County of Norfolk staff and one or more of those suppliers will be contracted if needed.

Table 1: Location coordinates and schedule for surface water sample collection at Turkey Point.

Sample ID	UTM	Baseline	12hr.	24hr.	48hr.	72hr.
LV1	17T 555449 4723805	X	X	X		
LV2*	17T 555188 4725522					

*LV2 will only be sampled if LV1 12hr. and 24hr. samples exceed the ODWQS for glyphosate. If this LV2 sampling is required, LV1 will also continue to be sampled every 24 hours until a downward trend in the glyphosate levels is confirmed below the ODWQS or a return to baseline levels is reached.

Lower Big Creek

A municipal water intake supplying Port Rowan and area is found in the Long Point Inner Bay over 1200m from the treatment location. The system is operated by the County of Norfolk and has a regulated intake protection zone of 1000m in diameter. Discussions with the County of Norfolk and the Haldimand-Norfolk Health Unit have been held to ensure awareness and knowledge of the pilot project and to discuss protection of water system quality. At the upstream end of the project area, landowners adjacent the Big Creek treatment areas have been notified of herbicide application.

Lower Big Creek will be treated in conjunction with phragmites on the Long Point Causeway. Water samples will be collected east of the mouth of Big Creek where it enters Long Point Bay. This sample location is proposed to ensure monitoring and protection for the Port Rowan municipal water intake. Additionally, a sample location is proposed just offshore from a group of residences on the Long Point Causeway to monitor private surface water intakes along the Long Point Causeway. Water samples will also be taken from a point in between the Causeway and Crown Marsh treatment sites, near Sandboy Marina and Marina Shores to ensure glyphosate levels don't exceed ODWQS. See Table 2 below for monitoring site coordinates and Figure 2 for a depiction on a map. A GPS point of the sample location will be taken at the time of sampling to ensure consistency. The samples will be analysed within a 24 hour turn-around time, for the presence of glyphosate. The laboratory will have a method of minimum detection limit of 0.005 mg/L for glyphosate which is more sensitive than the ODWQS of 0.028 mg/L. The purpose of this sampling is to confirm that glyphosate concentrations, post spraying, in the surface waters adjacent to the municipal water intake and private water intakes are less than the Ontario Drinking Water Quality Standard (ODWQS) for glyphosate. The results will be immediately reported to the Ministry of Environment and Climate Change and Haldimand-Norfolk Health Unit.

Table 2: Location coordinates and schedule for surface water sample collection at Lower Big Creek and the Long Point Causeway.

Sample ID	UTM	Baseline	12hr.	24hr.	48hr.	72hr.	96hr.
LBC1	17T 545298 4716881	X	X	X			
LBC2 intake*	Refer to Figure 5						

Causeway1	17T 546778 4714660	X	X	X			
Causeway2	17T 545696 4715578	X	X	X			

*LBC2 will only be sampled if LBC1 12hr. and 24hr. samples exceed the ODWQS for glyphosate. If this LBC2 sampling is required, LBC1 will also continue to be sampled every 24 hours until a downward trend in the glyphosate levels is confirmed below the ODWQS or a return to baseline levels is reached.

A map of the proposed sample area is below (see Figure 2). Baseline samples will be collected prior to the initial spray date adjacent the Big Creek treatment areas (200m east of mouth of Big Creek) with post-treatment samples occurring within 12 hours and again at 24 hours post-treatment until a downward trend in the glyphosate levels is confirmed or baseline levels are reached. The initial sample location for LBC1 will be 200m east of the mouth of Big Creek in the direction of the intake protection zone for the Port Rowan municipal water intake. Sample locations for Causeway1 and Causeway 2 are depicted on Figure 2.

If necessary, the ministry will continue sampling at 24 hour intervals post-treatment, to demonstrate a downward trend and that the levels are below the ODWQS. If glyphosate levels exceed the ODWQS, MNRF will conduct the next 24 hour interval sample at the Port Rowan municipal water intake (LBC2, see Figure 2). Arrangements will be made with the County to collect a treated water sample at the same time and submitted to a Licensed Accredited Laboratory. Should the raw water sample at LBC2 exceed or be equal to the ODWQS, then the treated water sample will be analyzed with expedited turnaround time. If samples taken from the raw water intake, and/or treated samples exceed the ODWQS, the Medical Officer of Health at the Haldimand-Norfolk Health Unit and the County of Norfolk will be consulted regarding next steps. Sampling at both the LBC1 and LBC2 (intake) will still continue at 24 hour intervals until a declining trend is evident and glyphosate levels fall and remain below the ODWQS. The MNRF has the option of trucking either raw water or potable water to the Port Rowan municipal water system if glyphosate levels at the water intake are found to be above the ODWQS. A list of approved water suppliers has been provided by County of Norfolk staff and one or more of those suppliers will be contracted if needed.

Water sampling adjacent to community of Long Point

Water samples will be collected in 2 locations adjacent to the cottage shoreline developments that fall within 800 metres of the herbicide application areas. A GPS point

Appendix C:

2017 monitoring plan for glyphosate concentrations in surface water samples adjacent to community of Long Point, Turkey Point and residences near the outlet of Big Creek (objective 5)

2017 Monitoring Plan for Glyphosate Concentrations in Surface Water Samples adjacent to community of Long Point, Turkey Point and residences near the outlet of Big Creek.

Water sampling adjacent to community of Long Point, Turkey Point and residences near mouth of Big Creek

This monitoring will address monitoring objective #5 (Monitor glyphosate concentrations in surface water samples adjacent to the community drinking water intakes that are near the herbicide application areas at Long Point, Turkey Point and the mouth of Big Creek). Similar monitoring occurred during the 2016 Pilot Project and all samples collected found glyphosate levels to be below the Ontario Drinking Water Quality Standard of 0.028 mg/L. Additional sampling is being proposed in 2017 due to the expansion of herbicide application at Lower Big Creek and Turkey Point. This year's sampling plan will provide assurances that plans are in place to notify and respond to the Ministry of Environment and Climate Change as well as the Haldimand-Norfolk Health Unit. A total of 6 sampling sites will be monitored. Two of these sites are at centralized locations adjacent to herbicide application areas in the Long Point Crown Marsh, three more sites are adjacent to treatment areas at Lower Big Creek and the Long Point Causeway, and one site is adjacent to treatment areas at Turkey Point. Please refer to mapping below for accurate depictions of sample sites.

Turkey Point

Background

A privately-owned intake, Lakeview Water Systems which supplies the residents of the community of Turkey Point with drinking water, is located offshore approximately 1500' from 10 Ordnance Avenue at a depth of approximately 10' – 12' below the surface of Lake Erie and 5' above the lakebed.. The Macdonald Turkey Point Marina uses a surface water system located at their boat ramp inside the marina channel system. A barrier berm of vegetated dry land 30m wide separates the treatment area from the Macdonald Turkey Point Marina property. All treatment within 125m of the Marina property line will be done using ground equipment to maximize application accuracy and minimize opportunity for herbicide drift. Discussions with the operators of Lakeview Water Systems and Macdonald Turkey Point Marina as well as the Haldimand-Norfolk

Health Unit have been held to ensure awareness and knowledge of the pilot project and to discuss protection of water system quality.

Sampling methodology

Water samples will be collected adjacent to treated areas which are located on the east side of the peninsula of Turkey Point only, due to the proximity to drinking water sources. Water samples are not proposed for areas west and north of the peninsula of Turkey Point due to the long distance to water sources, predominant current flow in Long Point bay and physical barrier of land between the treatment areas and any water intakes, resulting in a very low risk to drinking water quality.

Water samples will be collected approximately 1500' offshore at a depth of 10' – 12' and 5' above the lakebed to emulate the location and depth of Lakeview water systems intake (See Figure 2). The initial sample location will be due south from the entrance to the channel leading to MacDonald Turkey Point Marina. A GPS confirmation of the sample location will be taken at the time of sampling. The samples will be analysed within a 24 hour turn-around time, for the presence of glyphosate, by a laboratory that has received Canadian Association for Laboratory Accreditation (CALA), and holds a Ministry of Environment and Climate Change license for the glyphosate analysis in drinking water.

The laboratory will have a method of minimum detection limit of 0.005 mg/L for glyphosate which is more sensitive than the Ontario Drinking Water Quality Standard (ODWQS) of 0.028 mg/L. The purpose of this sampling is to confirm that glyphosate concentrations, post spraying, in the surface waters adjacent to the water intakes are less than the Ontario Drinking Water Standard (ODWQS) for glyphosate. The results will be immediately reported to the Ministry of Environment and Climate Change and the Haldimand Norfolk Health Unit.

A map of the proposed sample area is below (see Figure 1). Baseline samples will be collected at the proposed sample location (LV 1) prior to the initial spray date within the Turkey Point treatment areas, located east of the peninsula of Turkey Point. Post-treatment samples will begin at LV 1 within 12 hours and again at 24 hours after treatment, continuing until a downward trend in the glyphosate levels is confirmed or a return to baseline levels is reached (see Table 1). LV 1 is strategically placed in between the treatment areas and LV 2 (the water intake) to identify any potential herbicide in transit after treatment. Due to likeness of LV 1 and LV 2 in terms of depth

and distance from shore, as well as close proximity, it is proposed that a baseline sample is not needed at LV 2.

If necessary, the Ministry of Natural Resources and Forestry (MNRF) will continue sampling at 24 hour intervals post-treatment, to demonstrate a downward trend and that the levels are below the ODWQS. If at any interval, the glyphosate levels exceed the ODWQS, MNRF will conduct the 48 hour sample at the water intake for Lakeview Water Systems to confirm that levels entering the water system remain below the ODWQS. Arrangements will be made with the Lakeview Water Systems Operator to take a treated water sample simultaneously and if the raw water sample exceeds the ODWQS, the treated sample will be immediately analyzed by a Laboratory that is appropriately Licenced and Accredited to test Drinking Water Samples. Should this level exceed the ODWQS, the Medical Officer of Health (MOH) and the MOECC will be notified and consulted, a 72 hour raw sample and a treated water sample will be taken and next steps will be determined in consultation with the MOH. If directed by the MOH, the treated water sample will be submitted to a lab that is appropriately licensed and accredited to test drinking water.

The Lakeview Water System operator has confirmed the ability to fill their reservoir by truck in the event that contaminated water is suspected in the system. This will allow for the residents of Turkey Point to have a continuous supply of fresh drinking water should it be needed. The MNRF is prepared to truck this water in, if needed, to ensure potable water is available. A list of approved water suppliers has been provided by County of Norfolk staff and one or more of those suppliers will be contracted if needed.

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LV1	17T 555449 4723805	X	X	X		
LV2*	17T 555188 4725522					

*LV2 will only be sampled if LV1 12hr. and 24hr. samples exceed the ODWQS for glyphosate. If this LV2 sampling is required, LV1 will also continue to be sampled every 24 hours until a downward trend in the glyphosate levels is confirmed below the ODWQS or a return to baseline levels is reached.

Lower Big Creek

A municipal water intake supplying Port Rowan and area is found in the Long Point Inner Bay over 1200m from the treatment location. The system is operated by the County of Norfolk and has a regulated intake protection zone of 1000m in diameter. Discussions with the County of Norfolk and the Haldimand-Norfolk Health Unit have been held to ensure awareness and knowledge of the pilot project and to discuss protection of water system quality. At the upstream end of the project area, landowners adjacent the Big Creek treatment areas have been notified of herbicide application.

Lower Big Creek will be treated in conjunction with phragmites on the Long Point Causeway. Water samples will be collected east of the mouth of Big Creek where it enters Long Point Bay. This sample location is proposed to ensure monitoring and protection for the Port Rowan municipal water intake. Additionally, a sample location is proposed just offshore from a group of residences on the Long Point Causeway to monitor private surface water intakes along the Long Point Causeway (Causeway 2). If glyphosate levels exceed the ODWQS at Causeway2, water samples will also be taken from a point in between the Causeway and Crown Marsh treatment sites, near Sandboy Marina and Marina Shores to ensure glyphosate levels don't exceed ODWQS (Causeway1). See Table 2 below for monitoring site coordinates and Figure 2 for a depiction on a map. A GPS point of the sample location will be taken at the time of sampling to ensure consistency. The samples will be analysed within a 24 hour turn-around time, for the presence of glyphosate. The laboratory will have a method of minimum detection limit of 0.005 mg/L for glyphosate which is more sensitive than the ODWQS of 0.028 mg/L. The purpose of this sampling is to confirm that glyphosate concentrations, post spraying, in the surface waters adjacent to the municipal water intake and private water intakes are less than the Ontario Drinking Water Quality Standard (ODWQS) for glyphosate. The results will be immediately reported to the Ministry of Environment and Climate Change and Haldimand-Norfolk Health Unit.

Table 2: Location coordinates and schedule for surface water sample collection at Lower Big Creek and the Long Point Causeway.

Sample ID	UTM	Baseline	12hr.	24hr.	48hr.	72hr.	96hr.
LBC1	17T 545298 4716881	X	X	X			
LBC2	Refer to Figure 5						

intake*							
Causeway1	17T 546778 4714660						
Causeway2	17T 545696 4715578	X	X	X			

*LBC2 will only be sampled if LBC1 12hr. and 24hr. samples exceed the ODWQS for glyphosate. If this LBC2 sampling is required, LBC1 will also continue to be sampled every 24 hours until a downward trend in the glyphosate levels is confirmed below the ODWQS or a return to baseline levels is reached. Causeway1 will only be sampled if Causeway 2 12 hr and/or 24 hr samples exceed the ODWQS for glyphosate. They will also continue to be sampled every 24 hours until a downward trend in glyphosate levels are confirmed below the ODWQS.

A map of the proposed sample area is below (see Figure 2). Baseline samples will be collected prior to the initial spray date adjacent the Big Creek treatment areas (200m east of mouth of Big Creek) with post-treatment samples occurring within 12 hours and again at 24 hours post-treatment until a downward trend in the glyphosate levels is confirmed or baseline levels are reached. The initial sample location for LBC1 will be 200m east of the mouth of Big Creek in the direction of the intake protection zone for the Port Rowan municipal water intake. Sample locations for Causeway1 and Causeway 2 are depicted on Figure 2.

If necessary, the ministry will continue sampling at 24 hour intervals post-treatment, to demonstrate a downward trend and that the levels are below the ODWQS. If glyphosate levels exceed the ODWQS, MNRF will conduct the next 24 hour interval sample at the Port Rowan municipal water intake (LBC2, see Figure 2). Arrangements will be made with the County to collect a treated water sample at the same time and submitted to a Licensed Accredited Laboratory. Should the raw water sample at LBC2 exceed or be equal to the ODWQS, then the treated water sample will be analyzed with expedited turnaround time. If samples taken from the raw water intake, and/or treated samples exceed the ODWQS, the Medical Officer of Health at the Haldimand-Norfolk Health Unit and the County of Norfolk will be consulted regarding next steps. Sampling at both the LBC1 and LBC2 (intake) will still continue at 24 hour intervals until a declining trend is evident and glyphosate levels fall and remain below the ODWQS. The MNRF has the option of trucking either raw water or potable water to the Port Rowan municipal water system if glyphosate levels at the water intake are found to be above the ODWQS. A list of approved water suppliers has been provided by County of Norfolk staff and one or more of those suppliers will be contracted if needed.

Water sampling adjacent to community of Long Point

Water samples will be collected in 3 locations adjacent to the cottage shoreline developments that fall within 800 metres of the herbicide application areas. A GPS point of the sample location will be taken at the time of sampling but are also depicted below in Figure 3 and Table 3. Samples will be collected prior to the initial spray date within the Crown Marsh, and 12 hours and 24 hours post-treatment.

Table 3: Location coordinates and schedule for surface water sample collection at Long Point Crown Marsh.

Sample ID	UTM	Baseline	12hr.	24hr.	48hr.	72hr.
LPCM1	17T 548461 4714848	X	X	X		
LPCM2	17T 549549 4715139	X	X	X		
LPCM3	17T 548939 4715514	X	X	X		

The samples will be analysed within a 24 hour turn-around time, for the presence of glyphosate, by a laboratory that has received Canadian Association for Laboratory Accreditation (CALA). The laboratory will have a method of minimum detection limit of 0.005 milligrams/ L for glyphosate. The purpose of this sampling is to confirm that glyphosate concentrations, post spraying, in the surface waters adjacent to the shoreline developments of the Long Point community are less than the Ontario Drinking Water Quality Standard for glyphosate. The results will be immediately reported to the Ministry of Environment and Climate Change and Haldimand-Norfolk Health Unit. Due to logistics, the Long Point Causeway and very west portion of the Long Point Crown Marsh will be treated in conjunction with Lower Big Creek. Three sample sites will be monitored for this portion of treatment. Residents living on the Long Point Causeway and associated marinas will be notified in advance of the herbicide application and offered free bottled water if they rely on the use of surface water intakes.

If necessary, the MNRF will continue sampling at 24 hour intervals post-treatment, to demonstrate that the glyphosate levels follow a downward trend and are below the ODWQS. The MNRF will only notify residents to resume use of potable water systems once the level has been confirmed below the Ontario Drinking Water Quality Standard and MOECC and the HNHU have authorized the return to operations of these systems.

Free bottled water will be available for Long Point residents who rely on surface water intakes for potable water at the Long Point Provincial Park. There will be a designated

day advertised to residents where they may obtain water from the park where MNRF project staff will be in attendance to answer questions and provide information. Past that day, residents may contact the project supervisor to arrange bottled water pickup. Water is being offered to residents throughout the course of the herbicide application and until residents are notified that they may resume use of potable water systems.

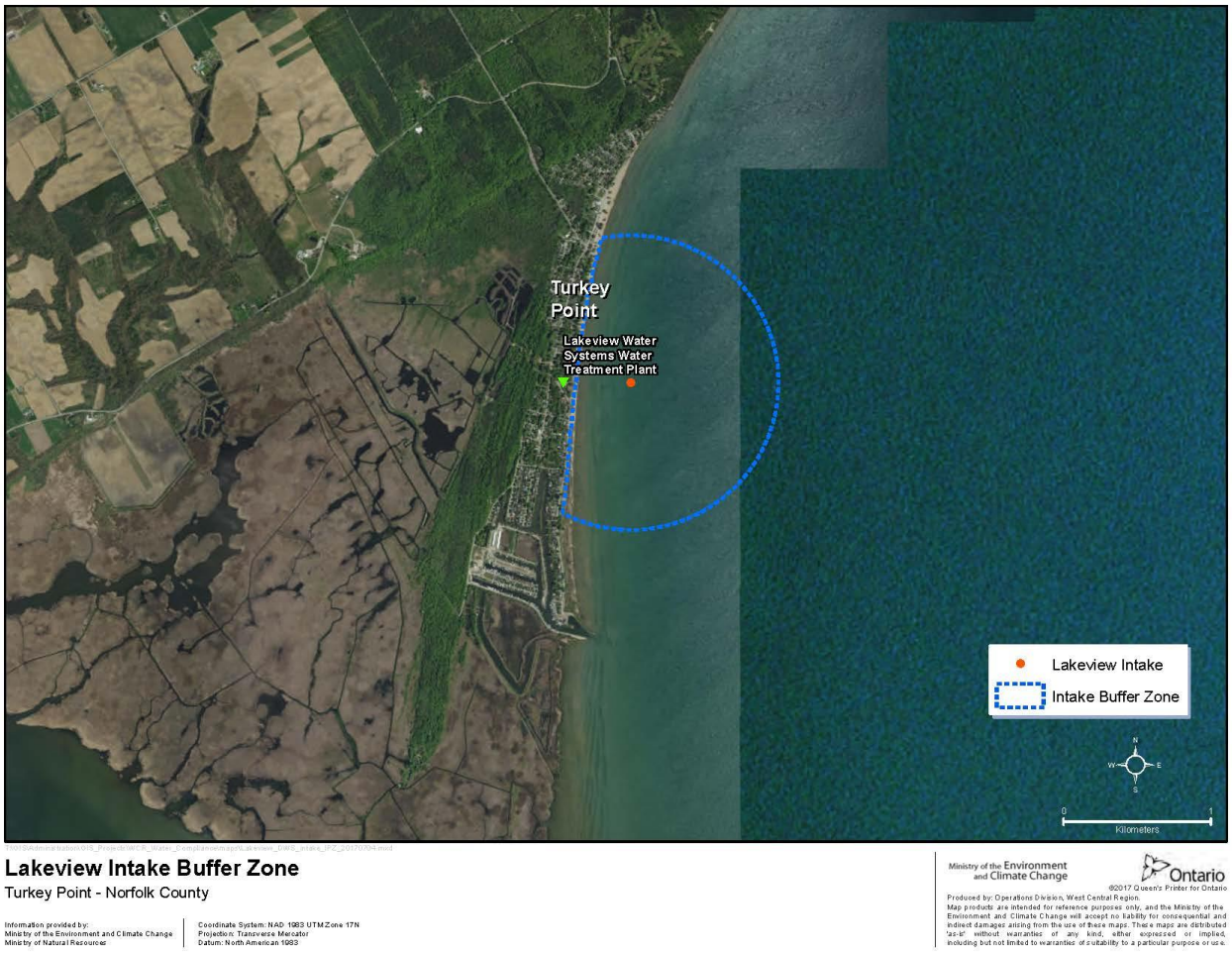
Proposed Water Sampling Locations for 2017 Phragmites Control Program in Long Point Region

Figure 1: Two proposed water sample locations to cover off the Turkey Point area. LV1 as the main sample site and LV2 (water intake location) as an alternate should glyphosate levels meet or exceed 0.028mg/L.

Figure 2: LBC1, and Causeway2 sample sites. LBC2 (intake location) and Causeway1 are proposed as alternates should glyphosate levels meet or exceed 0.028mg/L at LBC1 or Causeway2

Figure 3: Three sample sites at the Long Point Crown Marsh (LPCM1, LPCM2 and LPCM3) to be monitored in conjunction with herbicide treatments in the Crown Marsh.

Turkey Point Private Water Intake



Lakeview Intake Buffer Zone
Turkey Point - Norfolk County

Information provided by:
Ministry of the Environment and Climate Change
Ministry of Natural Resources

Coordinate System: NAD 1983 UTM Zone 17N
Projection: Transverse Mercator
Datum: North American 1983

Ministry of the Environment and Climate Change
Ontario

Produced by: Operations Division, West Central Region.
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Figure 4: Representation of Turkey Point private water intake and 1000 m intake buffer zone.

Figure 5: Representation of the Port Rowan municipal water intake and 1000 m protection zone surrounding the intake.