Final Evaluation Report of the Natural Edge Program in the Muskrat Watershed 2018-2020

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Muskrat Watershed Council

The Natural Edge Restoring the Ribbon of Life

Algonquin College | Office of Applied Research and Innovation

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1.0 Introduction

The purpose of this evaluation is to demonstrate how strategic restoration and conservation efforts through the Natural Edge Program can have long-term sustainable impacts on the health of the Muskrat Watershed, as well as its participating agricultural landowners. To accomplish this, several evaluation methods were conducted by Watersheds Canada located in Perth, Ontario, as well as the Office of Applied Research and the Environmental Technician Program, both located at Algonquin College's Pembroke Campus. These methods included pre- and post-program participant surveys, participant and program partner interviews, plant success counts, water quality testing, and community engagement.

The data collected, and subsequent evaluation presented in this document, can also be utilized by others in the non-profit and environmental sector who are delivering, or wish to deliver, similar stewardship and restoration programs to ensure resources are allocated appropriately for instilling and implementing widespread and lasting change.

2.0 Background

The Natural Edge Program is a shoreline naturalization program created and delivered by Watersheds Canada. It is geared towards waterfront property owners who wish to plant native trees, shrubs, and wildflowers along their shorelines (Watersheds C., nd). Results from previous Natural Edge Program evaluations identified that most waterfront property owners were aware of environmental issues and concerned about their impact on the natural environment; however, they lacked the knowledge and resources to carry out restoration efforts. The largest barriers identified by waterfront property owners was A) Limited understanding of how to restore their properties, including information on native vs. ornamental plants B) Limited ability to carry-out the work, but from a physical and financial standpoint. The Natural Edge Program looks to remove those barriers and has been successful at helping landowners restore their shorelines by providing financial support, creating restoration plans using native plants, as well as carrying out the planting.

In 2018, Watersheds Canada partnered with the Muskrat Watershed Council and Algonquin College's Office of Applied Research at the Pembroke Campus, with support from the college's Environmental Technician Program, to launch a unique, three-year version of the Natural Edge Program specific to the Muskrat Watershed. The Ontario Trillium Foundation provided the majority of program funding with additional donations received from LUSH Cosmetics Canada, Whitewater Brewery, SCBNA, M&R Feed and Farm Supply, Corteva Agri Science, Cabela's Outdoor Fund and Whitewater Township.

The Muskrat Watershed encompasses an area that stretches over five municipalities in the County of Renfrew. These include, North Algona Wilberforce, Township of Laurentian Valley, Township of Admaston/Bromley, Township of Whitewater Region, and the City of Pembroke. Water bodies within the Muskrat Watershed include Muskrat Lake, the Muskrat and Snake Rivers, Lake Dore, Black Creek, Mink Lake, Mink Creek, Olmstead Lake, and numerous other small creeks, streams, lakes and wetlands. With the total watershed covering an area of over 500 square kilometers (Watershed Council, M., 2019).

Muskrat Lake is the largest body of water in the watershed and is a natural resource valued for its fish and wildlife habitat, recreational activities, and residential development opportunities. The lake also provides drinking water for over 300 shoreline property owners and the nearby village of Cobden, Ontario.

Over the past several decades, Muskrat Lake and its tributaries have experienced a serious and significant decline in water quality, mostly resulting from nutrient loading from agricultural land-use. This, plus other contributing factors, have caused the annual proliferation of toxic blue-green algae blooms, eutrophication, and the general degradation of aquatic ecosystems. This threatens the natural environment in the Muskrat Watershed, poses a serious public health and safety risk, as well as negatively impacts the local economy (Watershed Council, M., 2019).

The Natural Edge Program in the Muskrat Watershed aimed to improve water quality within the watershed by partnering with 45 agricultural landowners to re-naturalize 3-km of agricultural streambanks with 45,000 Ontario native trees and shrubs. Over time, these re-established vegetative buffer zones will help to reduce soil loss due to erosion, filter out sources of agricultural run-off and generate new habitat for both wildlife and key pollinator species. To date, 45,000 trees and shrubs have been planted and returned an area of approximately 105,250m^2 (26 acres) to a natural state. Selected plants were a mix of shrubs and trees best suited for the growing zone (4a) and clay dominate soils.

A Natural Edge Steering Committee was formed to collaborate on key decisions surrounding planting logistics. This included volunteer and landowner recruitment, plant inventory, planting site preparation, health and safety, as well as site readiness (e.g., porta-potties, tent, refreshments, etc.). This committee was comprised of representatives from Watersheds Canada, Applied Research, and the Muskrat Watershed Council. Sites easy to access and traverse were planted by local volunteers consisting mainly of community members, school groups and small businesses. Sites considered as remote access, steep sloped and/or posed a possible safety risk to volunteers were contracted to professional tree planters. Tree planters were utilized heavily during the final year of the project (2020) due to COVID-19 and the restrictions put in place by local authorities preventing outdoor gatherings/events.

The time window for both volunteer and professional planting days was the end of October to the beginning of November each year. These dates were pre-determined and recommended by Ferguson Tree Nursery in Kemptville, Ontario. Ferguson Tree Nursery supplied all of the plants for the 3-year initiative. Compared to spring and early summer plantings, plants face less stress during the fall when dormant. Biodegradable coco mats were placed at the base of the plants to help with moisture retention, ground cover, and to control competition from nearby streambank grasses.

3.0 Evaluation Study Questions

To determine the program's success, several questions needed to be addressed in the areas relating to impacts to both the local physical environment and social environment.

Indicators for physical environmental impacts to determine overall program success included *in-situ* water quality and plant survival data collection. This form of data collection aided evaluators in understanding how well plants survived 1-2 years after installation and whether the riparian buffers are beginning to demonstrate positive influence on the streambanks and water quality of each restored location.

Indicators for social impacts focused on how the program negatively or positively influenced the local community, program partners, and participating landowners. Firstly, evaluators wished to understand the overall impact of the Natural Edge Program on participating landowners. Was there a noticeable increase or decrease in interested participants over the 3-year duration of the program? How did the program help to create a shift in understanding for landowners of how certain agricultural practices can negatively affect the surrounding natural environment? Did the program inspire landowners to continue implementing other agricultural best management practices on their properties? Evaluators also wanted to determine the landowners' overall experience with the program and if they would be willing to share their experience with others in the local agricultural community. Secondly, evaluators wanted to understand the impact reach of the Natural Edge Program, whether it inspired members of the community to build upon the idea of environmental restoration and rehabilitation. To determine this, evaluators emailed questionnaires to program partners and collected data on annual volunteer numbers, program participants, and the securement of other external funds to support the initiative.

4.0 Evaluation Procedures

The following section will cover the process and procedures used in the evaluation to measure the overall success and impact of the Natural Edge Program. Procedures used to address the impact of the program on the natural environment included conducting plant success counts and collecting water quality data. Social impact evaluation procedures included a blend of in-person and phone interviews, pre- and post-surveys, email questionnaires with participating program partners, as well as collecting community impact data to gauge volunteer involvement.

4.1 Plant Survival

During the final year (2020) of the Natural Edge Program in the Muskrat Watershed, representatives from Watersheds Canada and Algonquin College's Office of Applied Research visited past planting sites to determine how well plants had survived over the last 1-2 years and if certain species demonstrated better survival rates in the local environment compared to others. The procedure involved 1-2 individuals travelling along the streambank and manually counting all living, previously installed plants. Indicators included visible leaf, bud, stem or root colour/growth. All data and recorded comments were transferred to digital format and analyzed accordingly.

4.2 Participant Interviews and Surveys

Each agricultural landowner was asked to complete surveys to help assess their thoughts and knowledge both before and after participating in the program. Both pre-and post-planting surveys (Appendix B) contained similar questions, asking program participants a mix of multiple choice, short answer and ranking system (1-5) questions to help evaluators better understand the change in participants' overall knowledge and understanding of environmental stewardship and rehabilitation. In addition, in-person interviews were conducted by Watersheds Canada representatives with 2018-2019 participating landowners a year after their planting was completed. In-person interviews with program participants were used to expand further on the survey questions and related more specifically to how the program potentially impacted landowners on an agricultural scale, what they liked about the program, and if they have any suggestions or recommendations from an agricultural perspective.

4.3 Water Quality Sampling

To assess the potential impact of vegetative buffers on the local water quality, Environmental Technician students and Research Interns at Algonquin College's Pembroke Campus collected water quality data from Natural Edge Program planting sites before and after buffer installations (Appendix C). College interns and students used a combination of sampling equipment, such as a YSI Multiparameter Water Quality Probe, Hanna Handheld Combo Meter, HACH 9300, and a Hanna Dissolved Oxygen Meter to collect an array of water quality parameters. These included temperature, dissolved oxygen, pH, turbidity, and conductivity. Given the effects vegetative buffer zones have on controlling nutrient run-off from agricultural fields, samplers used the HACH Phosphorus Low Range TNT plus Vial Test (0.15-4.50 mg/L PO_4) and a Hanna Ultra Low Range Phosphorus Checker to determine changes in total phosphorus levels in the water after streambanks were planted. The data was transferred to Microsoft Excel for samplers to easily compare and track changes in water quality.

In addition, Watersheds Canada utilized the historical water quality data from the Muskrat Watershed Water Quality Monitoring Network available on the Muskrat Watershed Council's website. The Office of Applied Research and the Muskrat Watershed Council have been collecting water quality samples in the Muskrat Watershed at 24 + sites for over 6 years. The Ontario Ministry of Environment, Conservation and Parks analyzes the samples as an in-kind contribution. This has generated a robust historical database for water quality data in the Muskrat Watershed. This database provides important information on the watershed's water quality and nutrient levels from year-to-year between the months of May to August. This, in-turn, helps researchers, scientists, government agencies and interested members of the public better understand seasonal trends, potential impacts within the watershed, and to hopefully see a positive trend in water quality vis-a-vis the implementation of watershed projects and programs.

4.4 Community Impact Data and Partner Interviews

As part of the evaluation, Watersheds Canada wished to understand the indirect impact of the Natural Edge Program on the surrounding community and program partners. To do so, data was

collected on the number of volunteers participating, community contributions, and annual number of participating landowners.

Representatives from each partner organization completed partner interviews. The main partners interviewed included Julie Sylvestre, Managing Director for the Office of Applied Research at Algonquin College and Karen Coulas, Chairperson for the Muskrat Watershed Council. Questions asked in the interview pertained to the impact of the program on their respective organizations and its ability to build capacity so that each organization may continue this type of work in the future.

5.0 Findings

The following section presents the findings of the evaluation questions and procedures. To maintain property and landowner anonymity, each planting site was given a specific Planting Site ID number. Figure 1 shows the overall aerial view of the Natural Edge Program planting sites from 2018-2020. Figure 2 shows tree and shrub species planted each year.

Upon its completion in November 2020, Watersheds Canada had reached their goal of planting 45,000 native trees and shrubs along agricultural streambanks within the Muskrat Watershed. Contrary to the previously mentioned goals in section 2.0 Background, "*partnering with 45 agricultural landowners to re-naturalize 3-km of agricultural streambanks,*" Watersheds Canada actually partnered with 15 landowners and were able to re-naturalize over 11.8km of agricultural streambanks, covering a total area of 105,250m^2 (26 US Acres) (Figure 4). Rather than working with the anticipated 45 landowners, the project partners focused their efforts on working with 15 landowners, restoring large tracts of land which were having a negative impact on water quality. Changes to the original goal is an example of what happens when faced with the realities of a project being executed on the ground in real-time. It became clear that working with 45 agricultural landowners was less plausible, given the sheer size of the properties, this would require more than 45,000 native plants and shrubs, and many, many volunteers. Therefore, additional funding is needed in this region to continue this important work.

What became clear to the team is that engaging with fifteen agricultural landowners in a small agricultural community is actually a big win and allowed for the re-naturalization of more than the initial 3-km goal. As a result, the reduction in property owners meant an increase for plants planted at each site, meaning buffer strips were larger and covered longer distances along stream banks rather than planting many short, dispersed buffer strips, which would have proven to be a less effective method of restoration.

It is important to note that data concerning water quality and in-person interviews from 2020 participants was not included in this evaluation. This was due to an insufficient lapse of time between when the streambanks were re-naturalized (November 2020) and the subsequent submittal date of this evaluation (December 2020). Though baseline water quality data was collected/conducted at all five 2020 planting sites it will take 8-12 months before any possible change may be assessed. Suggestions concerning follow-up monitoring for these sites are included in this evaluation under Section 6.0 Conclusions and Recommendations.

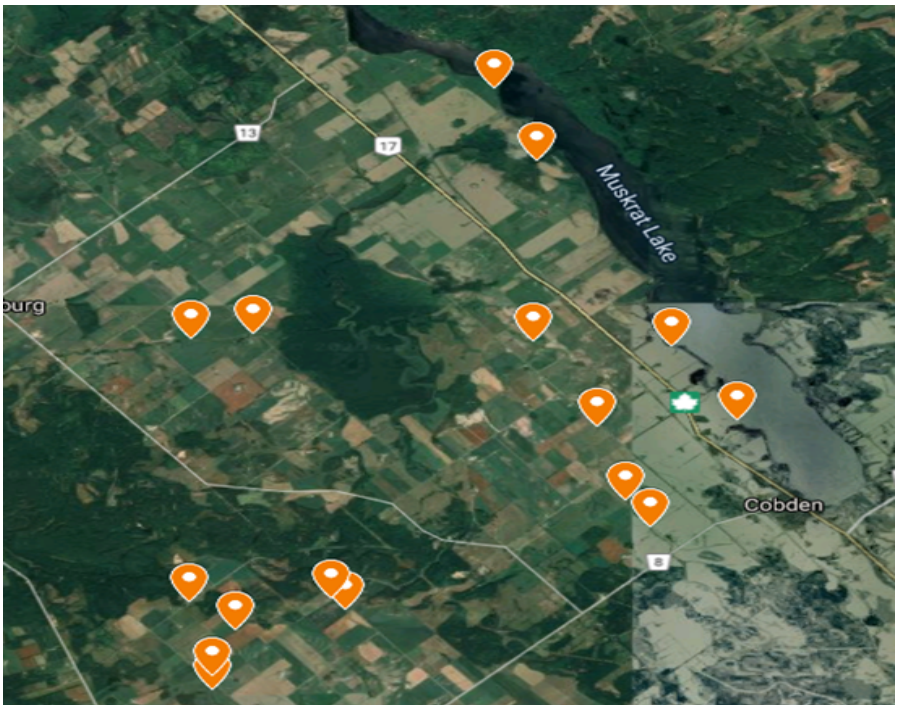

Figure 1: Aerial map of Natural Edge planting sites (2018-2020).

Native Plant Species Planted Each Year			
	2018	**2019**	**2020**
Native Plant Species	Speckled Alder Tamarack Sweet Gale Red Osier Dogwood Red Maple Pussy Willow Pasture Rose Paper Birch Fragrant Sumac Swamp Rose Buttonbush Bur Oak Bush Honeysuckle Alternate-Leaved Dogwood Silky Dogwood Gray Dogwood Black Elderberry	Bebb's Willow Black Elderberry Bush Honeysuckle Buttonbush Fragrant Sumac Grey Dogwood Highbush Cranberry Nannyberry Pussy Willow Red Maple Red Osier Dogwood Smooth Rose Speckled Alder Swamp Rose Tamarack Yellow Birch Chokecherry	Red Osier Dogwood Red Maple Paper Birch Nannyberry Fragrant Sumac Highbush Cranberry Arrowwood White Pine Chokecherry

Figure 2: Species of plant planted per year of the Natural Edge Program.

5.1 Plant Survival

Results from the plant survival success rate counts conducted in May 2020 revealed that out of the 30,000 trees and shrubs planted and assessed between 2018-2019, approximately 20,020 survived (Figure 4). On average, 48% ±10% of plants survived at sites planted in 2018 and 78%±10% for sites planted in 2019 (Figure 4). Of the plant species planted (Figure 2), the most successful recorded plant species across all 2018 and 2019 planting sites included Red Osier Dogwoods, Grey Dogwoods, Roses, Willows, Yellow Birch, Red Maple, Tamarack, Fragrant Sumac, Highbush Cranberry and Black Elderberry (Figure 5).

Natural Edge Program Plant Success Counts					
Site ID	**Year Planted**	**Initially Planted**	**Area Covered (m^2)**	**Plants Survived**	**Survival Percentage**
PS-01	2018	5,170	6,075	2,200	43%
PS-02	2018	1,580	2,123	600	38%
PS-03	2018	1000	920	500	50%
PS-04	2018	1,800	2,243	550	31%
PS-05 *	2018	5,450	5,705	4,200	77%
PS-06	2019	4,840	10,114	4,000	83%
PS-07	2019	5,380	30,870	4,300	80%
PS-08	2019	1,000	3,618	820	82%
PS-09	2019	1,500	3,756	1,100	73%
PS-10	2019	1,280	4,136	1,050	82%
PS-11	2019	1,000	7,038	700	70%

Figure 3: General plant data, survival count and percentage (2018-2019).
* 3,000 of 5,450 plants were replanted due to early plant loss from record breaking spring floods and summer drought.

Natural Edge Program Plant Survival Assessment	
Total Amount of Plants Assessed by Program Evaluators	**30,000**
Average Percent Survival Rate of 2018 Planting Sites	**48%**
Average Percent Survival Rate of 2019 Planting Sites	**78%**

Figure 4: A list of total plants assessed, as well as the survival rates (%) for 2018-2019 plantings.

Several factors were noted by surveyors as to why some sites had lower plant survival rates than others (Figure 5). Site PS-02 (38% survival) showed visible signs of livestock browsing after the installation of plants in 2018. Site PS-04 (31% survival rate) reported signs of plant die-off due to herbicidal spray application or drift and ploughing/cultivation along the upper sections of the vegetative buffer. Seasonal weather also appeared to impact survival rates. This was very apparent at sites PS-01 and PS-05. At PS-01, pussy willows planted in 2018 showed signs of root rot most likely due to the record-breaking spring rainfall and subsequent flooding in 2019. PS-05

experienced plant loss due to growth competition with local streambank grasses, severe spring flooding, and severe summer heat and drought in 2019. For this reason, Watersheds Canada and the Muskrat Watershed Council decided to replant part of PS-05 site in spring of 2020. Three thousand native plants were replaced after plant loss and were included in the spring 2020 plant survival counts. Surveyors also noted lower plant survival rates recorded at several sites along the upper ridges of streambanks where soil composition was often heavier in clay deposits. This heavy clay soil combined with consecutive high summer temperatures and long periods of drought would appear to have caused a higher rate of die-off when compared to lower, wetter, and cooler sections of the agricultural streambanks. Similar to site PS-05, most counts noted growth competition with pre-existing streambank grasses, even with the benefits of pre-placed coco-mats. Surveyors also noticed an anecdotal relationship between plant survival rates and the individuals who originally planted them. Even though a pre-planting orientation and how-to plant instructions were offered to participants on the morning of the plantings, some participants did not plant according to instructions due to human error and/or planter fatigue. In addition, in some cases, planting coordinators observed behavioral issues with some youth from the middle schools and high schools, which led to plants not being planted properly (barely in the ground) or leaving plants in areas without having planted them. Planting coordinators often corrected these issues, but given the size of each site, some plants were missed.

It is important to note that there is some variance in regards to observed plant totals. Firstly, some plants may have been missed by surveyors while walking the sites. The sites are quite large and surveyors couldn't account for the placement of every single plant when looking among the tall grasses. Secondly, during planting, smaller shrubs were often planted together with larger shrubs. This was done to ensure the small bareroot plants had a better chance of survival when competing with surrounding grasses. Therefore, what surveyors counted as one plant could in fact be two plants.

Natural Edge Program Plant Success Counts	
Site ID	**Additional Notes**
PS-01	Everything planted at the top line did well. Some willows survived but most showed signs of root rot due to extreme flooding
PS-02	Area showed signs of livestock browsing
PS-03	Lower Areas experienced flooding.
PS-04	A lot of plants lost due to visible signs of ploughing and spraying
PS-05	Select sections replanted with 3,000 plants in Spring 2020 due to high plant loss during severe drought in summer of 2019
PS-06	Plants survived better in lower areas along creek, compared to up on the ridge.
PS-07	Plants survived better in lower areas along creek, compared to up on the ridge
PS-08	Only Red Osier Dogwood was planted here
PS-09	Plants survived well along entire planting site.
PS-10	Entire planting did well. One section did particularly well, where an experienced volunteer planted.
PS-11	Site experienced flooding in Spring 2020.

Figure 5: Additional notes made by plant surveyors during success counts of 2018-2019 sites.

When evaluators compared plant losses in the Natural Edge Program to similar projects/studies, they found that survival rates were similar. A study conducted by Hans Michael Williams and Monica N. Craft on first-year survival and growth rates for bareroot, container, and direct seeded Nuttall oak stock on flood-prone agricultural fields found average survival rates of bare root stock to be around 40%. The study also showed that the time of year of planting, the handling of plants during pulling, storage, transport, and implantation also influenced the survival rate. When

comparing stock types and drought resistance, researchers also found that container stock fared better during drought conditions than bare root or direct seed (Williams, H. M., &; Craft, M. N., 1998).

Similar results were found in a study conducted by Steve Grossnickle and Yousry A. El-Kassaby in March 2015. Like Micheal and Craft, Grossnickle and El-Kassaby discovered that "Bareroot seedlings are more sensitive to handling practices of lifting, storage, transport and planting and these practices can negatively affect their performance. Container seedlings can have a higher level of field survival which is related, in part, to their greater drought avoidance potential, thereby overcoming planting stress" (Grossnickle, S., &; El-Kassaby, Y. A., 2015). When they investigated which stock did best when faced with plant competition they found that "In many instances where plant competition is the main limiting site variable, larger sized bare root and container stock types have the best chance for successful stand establishment" (Grossnickle, S., &; El-Kassaby, Y. A., 2015). This was also observed by the Natural Edge Program evaluators in successful plant species (Figure 5). Most of the species identified as "successful" were originally large bare root or container stock.

Most Successful Plant Species	
Site ID	**Plant Species**
PS-01	Red Osier Dogwood, Smooth Rose
PS-04	Red Osier Dogwood
PS-03	Red Osier Dogwood, Black Elderberry and Red Maple
PS-02	Roses, Red Maple, Red Osier Dogwood, Willow and Fragrant Sumac
PS-05	Red Osier Dogwood
PS-06	Highbush Cranberry, Red Osier Dogwood, Grey Dogwood, Willows and Tamarack
PS-07	Red Osier Dogwood, Willows, Roses, Fragrant Sumac, and Yellow Birch
PS-11	All did well but Willow did the best out of the 3 species planted
PS-08	Red Osier Dogwood
PS-09	Red Osier Dogwood, Grey Dogwood, and Highbush Cranberry
PS-10	Red Osier Dogwood, Willows, Choke Cherry and Roses

Figure 6: Most successful plant species recorded at each 2018-2019 site by plant survival surveyors.

5.2 Participant Interviews and Planting Surveys

Natural Edge Program participants completed the pre- and post- surveys provided by Watersheds Canada. Survey results showed a slight increase in landowner understanding of human impacts on freshwater and how one's actions can affect the surrounding environment. Post-survey results also showed an increase in understanding regarding what species of plants to plant along an agricultural streambank when compared to pre-surveys. The majority of landowners identified that the funding and assistance provided by the Natural Edge Program was important or very important to landowner participation.

For in-person interviews with participants, when asked how they heard about the program, answers varied. Some became aware of the program through personal referrals from fellow farmers while

others learned about the program through the initial Watersheds Canada information session held in spring of 2018. Other participants were already involved in past water quality projects in the Muskrat Watershed, therefore became aware of the Natural Edge Program through members of the Muskrat Watershed Council. All participants interviewed stated they were very aware or somewhat aware of the water quality issues in the Muskrat Watershed prior to participating in the program and had already started to implement agricultural best management practices on their farms. Since participating, all landowners expressed they are comfortable or very comfortable talking about their experience with the program with others in the farming community. One of the participants expressed concern in the plant survival rates on their property and how this may affect the long-term success and outcome of the program. A suggestion put forward by a past participant on how the program could be improved moving forward included spot spraying around freshly planted trees to better control the growth competition from adjacent streambank grasses. Suggestions from farmers on future projects included initiatives that would help offset the cost of implementing other best management projects, such as low-till, no-till, winter cover crops, soil health management, cattle fencing, and bridging along/across streams.

5.3 Water Quality Sampling

Phosphorus and aquatic plant and algal growth are intricately interconnected. The higher the phosphorus concentration in a freshwater ecosystem the greater the plant and algal growth (A, N., 2018). On the subject of water quality in the Muskrat Watershed, two types of phosphorus are readily discussed: Total phosphorus and reactive phosphorus (orthophosphates). These forms of phosphorus are a food source for cyanobacteria (blue-green algae), which blooms annually on Muskrat Lake. For the purpose of this evaluation, samplers decided to focus their study on total phosphorus concentrations rather than reactive. Total phosphorus concentrations contain both reactive phosphorus and the phosphorus contained within solids suspended in water. Total phosphorus also fluctuates less than reactive phosphorus, therefore it is considered a better indicator of possible impacts to water quality (A, N., 2018)

Water samples collected from 2018-2019 Natural Edge Program planting sites in the Muskrat Watershed showed an average drop of 67% in total phosphorus levels after plantings (Figure 8).

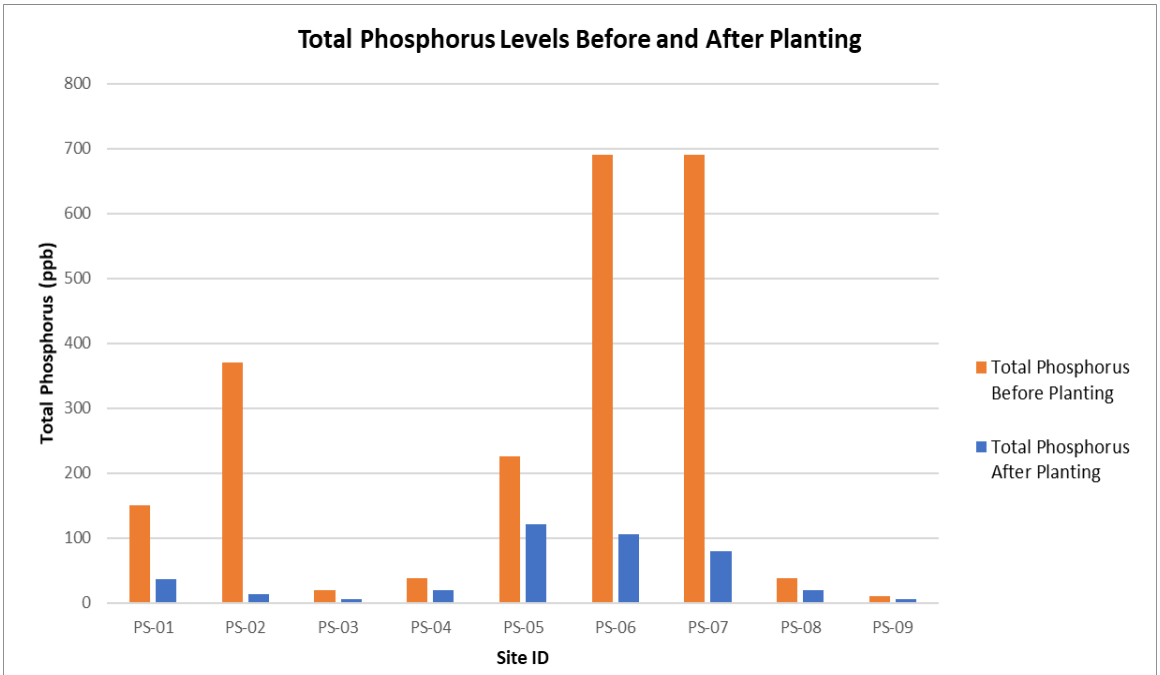

*Figure 7: Comparative chart of total phosphorus readings collected at 2018-2019 planting sites. **

Total Phosphorus Levels Before Planting vs Total Phosphorus Levels After Planting					
Site ID	Total Phosphorus Before Planting (ppb)	Site ID	Total Phosphorus After Planting (ppb)	Difference	Percentage Drop
PS-01	151	PS-01	37	114	75%
PS-02	370	PS-02	14	356	96%
PS-03	20	PS-03	6	14	70%
PS-04	38	PS-04	19	19	50%
PS-05	225	PS-05	121	104	46%
PS-06	690	PS-06	105	585	85%
PS-07	690	PS-07	80	610	88%
PS-08	38	PS-08	19	19	50%
PS-09	10	PS-09	6	4	40%
Average Percentage Drop					67%

*Figure 8: Percentage difference in total phosphorus levels for 2018-2019 planting sites. **

Turbidity is the relative clarity of a water source. Turbidity concentrations are determined based on how much light is displaced by suspended particles when projected through a water sample. It also influences the general cloudy or opaqueness of water. The higher the turbidity concentration, the cloudier the water (Science, W., n.d.).

Like phosphorus, higher levels of turbidity can negatively affect water quality, as well as indicate the presence of streambank/shoreline erosion. This, in turn, can lead to an increase in stream and lake sedimentation, which is detrimental to aquatic organisms, fish, and/or habitat. Suspended

particles in water also provides a surface for common water pollutants, such as heavy metals, nutrients, and bacteria to attach to (Science, W., n.d.).

When evaluators compared turbidity concentrations before and after planting at the 2018-2019 Natural Edge Program planting sites in the Muskrat Watershed, results varied. On average, there was a 14% drop in turbidity concentrations (Figure 10).

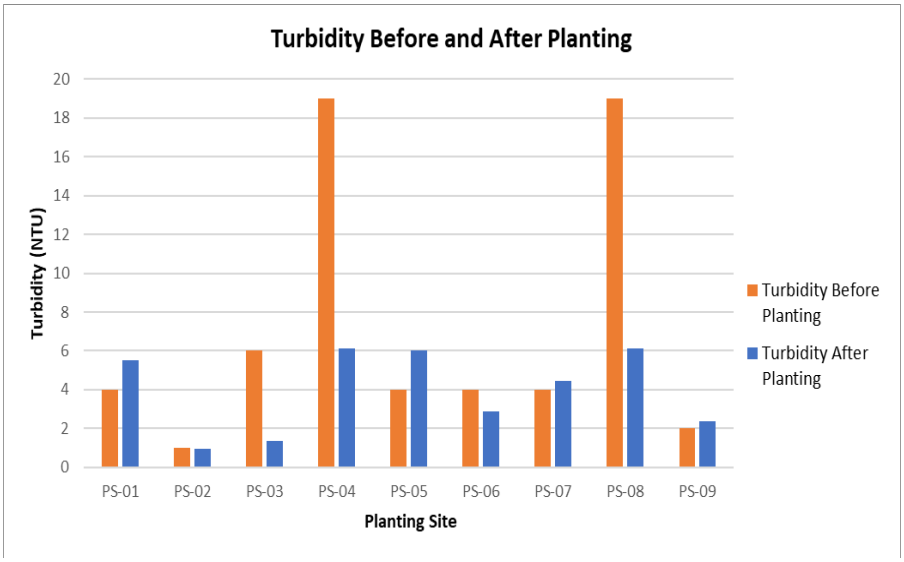

Figure 9: Comparative data of turbidity levels collected at 2018-2019 planting sites.

Turbidity Levels Before Planting vs Turbidity Levels After Planting	
Site ID	**Percentage Drop**
PS-01	-38%
PS-02	3%
PS-03	78%
PS-04	68%
PS-05	-51%
PS-06	29%
PS-07	-12%
PS-08	68%
PS-09	-18%
Average Percentage Drop	**14%**

*Figure 10: Percentage difference in turbidity levels for 2018-2019 planting sites. **

Given the water sampling results and the relatively short duration of the program in the Muskrat Watershed, evaluators cannot conclusively prove at this time that re-naturalized streambanks have had a significant impact on local water quality. It is important that the monitoring of these sites continue as the trees and shrubs mature and become fully established. Virginia State University

and Virginia Tech summarized several studies conducted on the long-term impacts of riparian forest buffers on water quality. In the case of soil erosion and stream sedimentation, scientists in North Carolina estimated 84-90% of sediment from cultivated agricultural fields was trapped in an adjoining deciduous hardwood riparian area. Similar percentages were seen with Nitrogen levels. A study conducted on Chesapeake Bay in Maryland estimated riparian buffers removed up to 89% of nitrogen run-off from agricultural fields (Klapproth, J. C., &; Johnson, J. E., n.d.).

When considering the site-specific conditions of the Muskrat Watershed, it is important to highlight the 2014-2017 Water Quality Report written by Environmental Toxicologist, Dr. Rebecca Dalton. In her recommendations, Dr. Dalton advises the Muskrat Watershed Council on possible agricultural best management projects/practices to help reduce nutrient levels and improve the overall water quality in the Muskrat Watershed. Under Section 4.5 *Considerations for improving water quality in the Muskrat Lake Watershed,* Dr. Dalton recommends other best management practices, such as conservation tillage, vegetated buffer strips, and cattle exclusion fencing, which she believed had the potential to improve water quality and reduce the export of nutrients to Muskrat Lake (Dalton, R. L., Ph.D., 2019).

*Please note: Planting sites PS-10 and PS-11 were not included in total phosphorus and turbidity results. Water quality data was not collected at PS-11 in accordance with the landowner's wishes. However, as planting site PS-06 is >200ft downstream from PS-11, evaluators assume that results for planting site PS-06 would be very similar to results collected from PS-11. Due to severe drought in 2019, evaluators were unable to collect the initial water quality data at site PS-10 until 2020 after plants were installed. Therefore, additional samples will need to be collected in the upcoming year(s) after the completion of the project.

5.4 Community Impact Data

To understand the scale of impact of the Natural Edge Program in the Muskrat Watershed and its surrounding communities, evaluators collected data on the annual number of participants, volunteers and additional external funding secured for the project. These processes were conducted and collected to better comprehend the possible impacts on the community from the Natural Edge Program over the last three years.

5.4a Participant Interest

Evaluators began by analyzing yearly participant numbers into three categories: Interested Farmers, Chosen Participants, and Number of Property Parcels Planted (Figure 11). Interested Farmers were individuals who contacted the Muskrat Watershed Council or Watersheds Canada expressing interest in participating in the project. Chosen Farmers were the individuals whose properties met the predetermined criteria by Watersheds Canada.

Number of Property Parcels was defined by one or both sides of a streambank being planted. If both sides of a streambank were planted, these were labeled as two separate property parcels.

Farmers' Interest and Participants Per Year			
	2018	2019	2020
Interested Farmers	8	7	8
Chosen Participants	5	4	5
Number of Property Parcels Planted*	8	10	5

Figure 11: Farmer interest, chosen participants and number of property parcels planted from 2018-2020.

When comparing Interested Farmers vs. Chosen Participants, numbers stayed relatively steady from 2018-2020 (Figure 11). The fluctuations in planted property parcels is attributed to planting both sides of streambanks in 2019 in comparison to 2018 and 2020 where most sites only had one side of the streambank planted.

5.4b Annual Volunteers

Planting Volunteers Per Year						
Organizations	Years Participated			Volunteer Numbers per Year		
	2018	2019	2020	2018	2019	2020
JP2G	X	X		18	10	
Fellowes Highschool	X			75		
Algonquin College	X	X	X	69	114	15
Equinox		X			18	
Valour Highschool		X			43	
Community Volunteers	X	X		54	18	
Opeongo Highschool	X	X		60	35	
Total Volunteer Turnout per Year				**276**	**238**	**15**
Total Average Volunteer Turnout per Year						**176**

Figure 12: Breakdown of planting volunteers per year (2018-2020).

Similar to program participants, evaluators compiled volunteer numbers from 2018-2019 (Figure 12). Annual volunteers were comprised of local high schools, colleges, small business and community volunteers. In the first year of the project, approximately 276 individuals participated in the volunteer fall planting days. Similar numbers were seen in the following year with 80% of 2018 volunteers returning to plant in 2019.

The slight drop in numbers from 2018 to 2019 may be explained by a change made by Watersheds Canada and the Natural Edge Steering Committee. An evaluation conducted by the Steering Committee on volunteer numbers and attendance in 2018 revealed that the majority of the volunteers came from businesses and educational institutions, less so from individual persons. In addition, the Steering Committee implemented an age restriction of 14 and over to ensure the health and safety of volunteers.

Based on attendance results from 2018, the Steering Committee decided to organize fewer planting days on the weekend and more from Monday to Friday in the daytime to better accommodate the majority of volunteers. This scheduling resulted in a decrease of community volunteers but an

increase in the number of educational institutions able to attend. A major change to the scope of the project based on what was stated in the original application occurred in 2020 with the unpredicted global pandemic. As the majority of native trees and shrubs were previously planted by volunteers, this needed to be reassessed to meet the safety regulations put forth by local health authorities due to COVID-19. It was agreed upon between the Steering Committee that one planting day would be offered to a very small group of volunteers (approx. 15 people) (Figure 12), while the remainder was to be allocated to professional tree planters.

5.4c Additional Funding

Community Funders Per Year				
Funder	**Year Donated**			**Approximate of Funds Donated**
	2018	**2019**	**2020**	
LUSH Cosmetics	X	X		$ 22,500.00
Whitewater Brewery		X		$ 1,300.00
M&R Feeds and Farm Supply		X		$ 8,500.00
Whitewater Township		X	X	$ 4,459.51
Corteva Agriscience			X	$ 2,000.00
Cabela's Outdoor Fund			X	$ 2,500.00
Number of Funders per Year	**1**	**4**	**2**	
Total Community Funds Raised				**$ 41,259.51**

Figure 13: Breakdown of community funds per year (2018-2020).

To better understand the program's success, evaluators investigated the correlation between the 3-year program and additional community funding received during that time. These funds were awarded and/or donated specifically for the purpose of the Natural Edge Program. The listed values above (Figure 13) were utilized to help offset external and unforeseen costs of the program not covered by initial funding from the Ontario Trillium Foundation. Some of these external costs included the 25% participating landowner fee, hiring professional tree planters to plant in remote/rugged terrain sites, and busing for schools.

The data showed a significant increase in external funding sources in 2019 compared to 2018. In considering funding sources for 2020, it is important to note that because of the global coronavirus pandemic, a large majority of previously available funding for the non-profit sector was re-routed, frozen or withheld from certain organizations to help support research related to the on-going pandemic.

5.5 Partner Interviews

An email questionnaire was sent to Karen Coulas, Chairperson for the Muskrat Watershed Council and Julie Sylvestre, Managing Director for the Office of Applied Research. The questionnaire assisted evaluators in understanding the impact the Natural Edge Program had on both partner organizations, whether these organizations had any recommendations for the program, as well as provided the opportunity to gather insight on the possibility of a continuation of similar restoration efforts beyond the current program.

Karen Coulas wrote how the Natural Edge Program helped connect the Muskrat Watershed Council to more individuals in the surrounding community to raise awareness and share knowledge on the water quality issues in the Muskrat Watershed. She also explained that the program helped create new relationships and nurtured current relationships with farmers in the watershed. This indirectly opened the door for new ideas, suggestions, funding sources, and partnerships for future projects. One of the questions included: *"Do you think the Natural Edge Program helped your organization build capacity to continue this type of work in the future?"* Karen replied: "I believe it [the Natural Edge Program] has given our group a firm understanding of how to run a program like this and we would like to continue this type of program on our own in the future."

Julie Sylvestre described the impact of the Natural Edge Program on both the participating students and Algonquin College as an institution: "The Natural Edge Program has provided our environmental programs the opportunity to offer students hands-on learning while increasing awareness amongst our students and faculty of local environmental issues." She continued by explaining how students volunteered to help plant outside of class hours, providing students with the opportunity to act on their pro-environmental beliefs and attitudes. College professors also took their own initiative by incorporating the planting days into their fall course projects and teaching schedules. When looking at the impact of the program on Algonquin College as a whole, Julie explained: "Through such projects, the college has the opportunity to act on principles it claims to espouse, such as environmental sustainability and social responsibility." When asked if the Natural Edge Program helped build Algonquin College's capacity to continue this type of work in the future, Julie responded: "[The Natural Edge Program] got the college more involved in community-based environmental initiatives, which I think will continue into the future if the [Muskrat Watershed Council] decides to access more funding to continue the project."

6.0 Conclusions and Recommendations

Based on the results of this study, evaluators believe there is clear evidence to support the program's overarching goal of strategic restoration and conservation efforts in the Muskrat Watershed. Moving forward, evaluators have compiled recommendations for Watersheds Canada on how they could potentially improve on their agriculturally focused delivery of the Natural Edge Program.

When examining the recorded plant losses at each site and the potential causes for these losses, there were several suggestions brought forward. In the case of plant loss due to livestock browsing,

evaluators recommend an amendment to the Memorandum of Understanding signed and agreed upon by Watersheds Canada and the landowner. This would include ensuring there is secure livestock fencing present around the designated planting site shortly before planting, including a commitment from the landowner not to allow livestock in planted areas. Plant loss attributed to crop spray was addressed during the second year of the program by ensuring a 1-meter buffer between the newly planted trees and shrubs and agricultural fields. Similar to cattle fencing, evaluators also suggest discussing with farmers about flagging or marking the planted streambanks, which would indicate a no plough or spray zone. Another recommendation included spot spraying around newly planted trees and shrubs to decrease the chance of over competition from nearby streambank grasses. Other conservation authorities, forestry companies, and environmental organizations already utilize this method. It is important to note that spot spraying would be conducted by licensed/trained individual(s) and would only be conducted once a year for a maximum of two or three consecutive years after installation. It was discussed that Watersheds Canada representatives would also ensure they are clear in discussions with landowners around the normality of a 50% loss of plants after the first or second year. In addition, as seen in this evaluation and comparative studies, the larger bareroot and container stock plants had a better survival rate. Therefore, it is recommended that future projects allocate funds to planting fewer larger plants, rather than many smaller plants. This should help to increase the survival rate.

Based on water quality data and the information from external studies on forested riparian zones, it is recommended that Watersheds Canada instill a more long-term monitoring program in order to fully understand the impacts of this program over time, as well as collect follow-up information surrounding the partially omitted 2020 planting sites.

For future funding for a similar delivery of the Natural Edge Program, evaluators recommend budgeting for possible replacement plantings and professional tree planters to plant sites less accessible by public volunteers and schools. Similar budget considerations are recommended for the 25% landowner fee originally included in the cottage owner version of the Natural Edge Program. Given the scope of the project in the Muskrat Watershed, it would be extremely difficult for farmers to pay the full 25% fee, as agricultural streambanks cover a greater distance than lakefront or riverfront properties. On average, each streambank site spans a minimum of 1-km in length and requires 1,000-5,000 plants. For future delivery of the project, evaluators recommend the budgeting or securing of additional funds to cover or offset the 25% landowner fee for agricultural participants.

Recommendations for issues of plant success and disinterested volunteers include hosting presentations at local high schools to engage students and educate them on the importance of the program, as well as to introduce concepts and examples of environmental stewardship and restoration. Similar to hosting presentations at high schools, it may be beneficial to host more info sessions for members of the public, covering similar subjects as the high school presentations. Continued and regular communication of the program's benefits through digital/social media avenues would also be helpful. Evaluators understand that education and public awareness only go so far. As such, another recommendation includes investigating the possibility of dividing larger agricultural streambanks into smaller sections over a span of several days. This makes it easier for planting coordinators to manage volunteer groups to ensure planting is done properly.

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Appendix A: Interview Questions (Attached Separately)

1. Farmer Interview Questions
2. Partner Emailed Interview Questions

Appendix B: Pre and Post Surveys (Attached Separately)

1. Pre-planting Survey
2. Post-planting Survey

Appendix C: Water Quality Data (Attached Separately)

1. Water Quality Data 2018-2020, collected by Algonquin College students