FRESHWATER MICROPLASTICS
AND
LAKE ONTARIO MUNICIPALITIES

STEPHANIE R. HULSE

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ABSTRACT

In 2005, the United Nations Environmental Programme (UNEP) identified plastic pollution as a top environmental crisis facing our species (Mason, et al., 2016, p. 1045), and yet plastic production and pollution has drastically increased over the last ten years. Researchers have reported the presence of plastic particles in almost every part of the world (Geyer, Jambeck, & Law, 2017, p. 1), and while awareness of marine plastic pollution has increased, research on dangerous microplastic (MP) pollution in Lake Ontario is limited. This MES Portfolio first explores freshwater microplastics and the role of Ontario municipalities in mitigating them, then focuses the City of Toronto's ability to protect Lake Ontario. Finally, the Portfolio reviews my outreach experience supporting a prominent environmental non- governmental organization (ENGO) to raise awareness of plastic pollution and identify the top corporations who are polluting Canada with single-use plastics (SUPs).

DEDICATION

I would like to dedicate this MES Portfolio to my parents Jonathan and Marie; words cannot express my gratitude for their unwavering guidance, support and love. They raised me to revere nature and I strive to match their hard work ethic, DIY attitude, strength in character and kindness. To my brothers, Greg and Matthew for inspiring my environmentalism, empowering me to use my voice and supporting me as I chase my dreams. To Robbie, whose patience, support and love has been the bedrock of this process and has kept me sane and smiling. Finally, to my friends and family, who provided adventure and laughter when the going got tough.

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Introduction

In recent years the Great Pacific Garbage Patch (GPGP) has received increasing public awareness, with many seeing it as indicative of the throw-away lifestyle of contemporary culture. The GPGP is predominantly comprised of single-use plastics (SUPs) that threaten the oceans, which make up 70 percent of the globe. While the GPGP conjures images of a "plastic island" in reality the patch is make up of tiny plastic particles- also known as microplastics (MP)- taking the consistency of a murky soup (Barry, 2009). Tiny but deadly, MPs are minute plastic particles that offer a diverse set of environmental threats including the emission of GHGs, severe harm or death to wildlife, and they support the colonization of dangerous bacteria and invasive species. Despite the growing awareness of ocean plastic pollution, few people realize that similar MP patches are developing on southern Ontario's doorstep, as Lake Ontario has levels of MP pollution that rival the GPGP. However, unlike the pollution found in the GPGP which is accrued from global sources, the MPs in Lake Ontario are the result of mismanaged waste in North America, and they pose significant threats to local ecosystems and human health. In fact, while freshwater MP research is in its infancy, reports suggest that the impacts of freshwater MPs have greater implications (Rochman C. , 2018, p. 29). Given these threats, it is vital that government action is taken to ensure the protection and conservation of this source of freshwater.

While the impact on humans has yet to been concluded, the presence of MPs have been found in drinking water (Tyree & Morrison, 2017), fish sold for human consumption (Rochman, et al., 2015), and the presence of plastic chemicals in humans corelates with an increase in health complications. Over time plastics break down into smaller pieces, until they are invisible to the naked eye and are able to evade most processes of filtration and capture. The two most common sources of MP pollution derive from mismanaged waste, and wastewater treatment plants (WWTP). Currently around 50 percent of plastic pollution is composed of single-use plastics (SUPs) (UNEP, 2018, p. 5) making them both the primary source of MP pollution, and the obvious type of plastic to target in order to mitigate MP pollution. In addition to SUP pollution, reports indicate that 70 percent of Lake Ontario's plastic pollution is comprised of microfibers, which are released from washing clothing. This suggests that Ontario municipalities, who are

tasked with waste management, must evolve both their waste management strategies and treatment systems to manage the pollutants of the 21st century.

Waste in Ontario

In a response to waste management and environmental issues, the Ontario provincial government recently enacted the *Waste-Free Ontario Act, 2016,* and with it the Strategy for a Waste Free Ontario. While waste reduction policies are important, the strategy focuses on developing a circular economy, which includes goals to lengthen product and packaging life and improve waste management systems. Yet tangible prevention of plastic pollution requires stemming the pollution at the source, which would equate to banning problematic plastics such as SUPs. These disposable plastics are generally used for plastic packaging and include items such as grocery bags, food packaging, bottles, straws, containers, cups and cutlery (UNEP, 2018, p. 2). Eliminating problematic plastics would have additional benefits including a reduction in waste sent to landfills and a reduction in GHG emissions. However, while some Canadian municipalities, such as Victoria, Vancouver and Montreal have taken steps to ban SUPs, Ontario municipalities have been slow address SUPs and as such, are delaying an opportunity to become environmental leaders. Unfortunately, there is an urgency for Ontario municipalities to act, because like all of the Great Lakes, Lake Ontario has become a dumping ground.

In general, the Great Lakes are incredibly important as they hold 21 percent of the world's freshwater (Lake Ontario Waterkeeper, 2018), host hundreds of diverse ecosystems and endangered species, are a water source to over nine billion people, and play an enormous role in North America's economy and tourism (Government of Ontario, 2018). However, the increasing impacts of climate change make freshwater a threatened resource, and in the coming decades such a commodity will be globally sought after. Such issues are particularly pressing given that the Great Lakes are already degraded due to decades of urbanization and industrialization (both manufacturing and agricultural) in the surrounding areas. Further, a recent report suggests the Lakes have become a dumping ground for mismanaged waste with nearly 10,000 tons of waste released into them annually (Hoffman & Hittinger, 2016). While studies suggest that more waste is dumped into Lake Erie, reports have discovered levels of MP in Lake Ontario that are 10 x higher than those in Lake Erie, and even rival levels found in the GPGP (Allen, 2012). Reasons for this accumulation of MP pollution may involve Lake Ontario's role as a receiving basin for

the other Great Lakes, and Lake Ontario's unique circulation gyres which encourage large clusters of MPs to develop in its south-west corner. Yet, regardless of how the pollution has accumulated, the presence of MP pollution threatens the environment and humans and it is therefore the duty of governing bodies to address it.

Aquatic pollution is a result of mismanaged waste and reflects ineffective waste management systems and a negligence of environment protection. While environmental protection is the concern of all levels of Canadian government, waste management systems are left to municipalities to organize, develop and manage under provincial regulations. However, it appears Canadian municipalities cannot handle the waste it produces. In 2017, the Canadian Geographic reported that Canadians produced 720 kilos per capita of waste annually (Wilkins, 2017), and yet only 11 percent of plastic is recycled annually (Environmental Defence, 2018). This leaves nearly 90 percent of the country's plastic waste to be dumped in landfills or pollute the environment. More specifically, within in Ontario, "over 70 percent of products at their end-of-life, packaging and other waste is sent to landfill" (Government of Ontario, 2017, p. 25). These issues have been made all the more pressing of late, as China announced in 2017 that it would no longer accept Canada's low quality recyclables. China had been collecting around 20 percent of Canada's plastic waste, and now Canada is forced to reconsider its waste management systems (Bula, 2018). It has also sparked municipalities, such as the City of Toronto, to revisit their waste management strategies and address SUPs. This overview proceeds by first discussing the history of plastics and pollution, then exploring the complexities of MPs and their sources, and finally delves into the role of municipal government to address this pollution.

Plastic & Pollution

Composed of a series and chains of polymers and monomers, such as fossil-fuel based ethylene and propylene, synthetic plastics became popular in the early 20th century for their lightweight, durable, and inexpensive qualities. In the economic and manufacturing boom that followed WWII, the plastics industry cemented itself in society by offering cheaper and more versatile alternatives to traditional materials such as glass, wood and metal. In order to create different types of plastics, additives and chemicals are added to plastic resins to provide varying degrees of flexibility, water resistance, or durability- depending on the product's need. Unfortunately, additives are generally "not chemically bound to the plastic polymer and only

reactive organic additives (e.g. some flame retardant) bond with the plastic molecules and become part of the polymer chain" (COWI, 2013, p. 12). These chemicals are later released when plastic deteriorates causing dangerous repercussions when released into the environment. Nonetheless, plastic production is on the rise and today, the plastic industry's largest market is its plastic packaging sector (UNEP, 2018, p. 4), and its growth has been "accelerated by a global shift from reusable to single-use containers" (Geyer, Jambeck, & Law, 2017, p. 1).

A 2017 study found that 8300 million tons of plastic have been produced in the last 65 years, and production shows no sign of slowing down (Geyer, Jambeck, & Law, 2017, p. 1). Further, according to a 2018 report, the "global annual consumption of plastic has now reached over 320 million tons with more plastic produced in the last decade than ever before" (Lebreton, et al., 2018, p. 1). With only nine percent of all plastic ever created has been recycled, 12 percent has been incinerated and 79 percent has been left to accumulate in landfills or has been lost to the natural environment (UNEP, 2018, p. 6). Due to bad waste management practices, wasteful product designs, neglect of environmental impacts, and a "lack of policies that support a circular plastics economy" (Ballent, Corcoran, Madden, Helm, & Longstaffe, 2016, p. 383), it is estimated that "four to 12 million metric tons of plastic waste generated on land [entered] the marine environment in 2010" (Geyer, Jambeck, & Law, 2017, p. 1). Such levels of land-based pollution ought to ring alarm bells with government bodies, as mismanaged waste is linked to a range of negative environmental and public health problems.

Suffice it to say, the creation of plastics has paved the way for a myriad of technological advancements since the mid 20th century of benefit to a range of social good from the housing sector to the medical field. However, the greatest asset of plastics– durability– has proven to be their greatest weakness. Once discarded, unlike organic matter whose energy and nutrients can transfer back into the environment, plastics resist degradation. Plastics are not biodegradable and when left to accumulate in landfills or in the environment, they break down into smaller pieces with the help of friction, erosion, UV rays, and a combination of these and other natural factors. As plastics are fossil fuel-based the "only way to permanently eliminate plastic waste is by destructive thermal treatment, such as combustion or pyrolysis. Thus, near-permanent contamination of the natural environment with plastic waste is a growing concern" (Geyer, Jambeck, & Law, 2017, p. 1). Indeed, the permanence of plastics has been a longstanding

concern. When researchers discovered the first instance of mass aquatic pollution- the GPGP- in the 1970s, environmentalists and environmental scientists became extremely concerned.

In 1986, one such researcher, Michael J. Bean, recognized that society could not handle its waste, and with SUPs only just then on the rise, Bean called for existing legal authorities to address the problem of marine plastic pollution and recommended additional solutions (Bean, 1987, p. 357). Thirty years later, the United Nations (UN) has named plastic pollution "one of the top environmental issues facing our species" (Mason, et al., 2016). Traces of plastic have been discovered in almost every part of the world, from the environment to wildlife to humans, to such a degree that "plastic waste is now so ubiquitous in the environment that is has been suggested as a geological indicator of the proposed Anthropocene era" (Geyer, Jambeck, & Law, 2017, p. 1). However, plastic is not only littering our environment, but it is having a tremendous impact on climate change through way of GHG emissions.

Due to their fossil-fuel base, plastics also contribute to GHG emissions both in their production and in their disposal. GHG are hazardous as they "directly influence climate change- affecting sea level, global temperatures, ecosystem health on land and in the ocean, and storms, which increase flooding drought and erosion" (University of Hawaii at Manoa, 2018). Within their production, the plastics industry "consumes seven- eight percent of global oil and gas production, and production has doubled in the last 20 years" (Partridge, Acker, & Colwell, 2018, p. 2). The UN suggests that "if the growth in plastic production continues at the current rate, by 2050 the plastic industry may account for 20 percent of the world's total oil consumption" (UNEP, 2018, p. 2), and, "15 percent of the annual carbon budget" (Partridge, Acker, & Colwell, 2018, p. 2). Additionally, six percent of the Ontario's total GHGs "come from the waste sector- 90 percent of this is from landfill- and the number is increasing" (Government of Ontario, 2017, p. 25). Additionally, a recent study discovered that plastics emit GHG infinitely, and even more so as sunlight aids into their decomposition into MPs (Royer, Ferron, Wilson, & Karl, 2018).

With a breadth of studies available demonstrating a correlation between plastic and the deteriorating health within humans, animals, and the planet it is critical that governments reconsiders its reliance on plastics. To do so, the logical approach would be to eliminate problematic plastics such as SUPs. Such an elimination would remove nearly 50 percent of the world's production of plastic which would dramatically reduce GHGs, elevate pressures within

waste management systems, and divert around 70 percent of waste from landfills and the environment.

Mighty Microplastics: The Importance Of Waste Management

Aside from the impacts of climate change, minimizing the presence of plastics in the environment is extremely important, because plastics will inevitably deteriorate into MPs and increase their potential to harm the environment. Reports suggest that MPs have been accumulating in the marine environment over the last four decades (Secretariat of the Convention on Biological Diversity , 2016, p. 19), and plastic is believed to be "present in all marine habitats from pole to pole and from the ocean surface to the seabed" (Secretariat of the Convention on Biological Diversity , 2016, pp. 19-20). In 2016 the UN documented, "over 800 animal species contaminated with plastic via ingestion or entanglement- a figure 69 percent greater than that reported in a 1977 review, which estimated only 247 contaminated species" (Smith, Love, Rochman, & Neff, 2018, p. 3). It is now clear that "every level of the food web is exposed to microplastics, from primary producer to higher trophic-level organism" (Secretariat of the Convention on Biological Diversity , 2016, p. 20).

Although awareness of plastic pollution has increased, it is important to establish definitions and categories for plastic debris so as to develop a thorough understanding of the crisis. Generally, plastic debris are grouped into the following five categories: nanoplastics, plastic particles measuring < 0.05 cm; MPs, particles measuring 0.05- 0.5 cm; mesoplastics, particles measuring 0.5- 5 cm; macroplastics, particles measuring 5- 50 cm; and megaplastics, particles measuring > 50cm (this article encapsulates nanoplastics within MPs for the sake of simplicity). While meso, macro and mega plastics are more likely to be captured by waste management systems or removed with the help of city organized or community cleanups, MPs are small enough to evade all traditional waste management systems and are nearly impossible to capture once released in the environment. Given their diversity in size, complexity, and impact, MPs have been subdivided into five further categories of microbeads, microfibers, fragments, pellets and styrofoam. Microbeads are found in cosmetic and cleaning products. Common examples of microfibers include fibers released from polyester and nylon fabric, or from larger particles, such as tires. Fibers can also be found in cigarette butts, which are often tossed into gutter and stormwater catch basins. Fragments include any plastic particles that have broken off

larger pieces, and they are generally unidentifiable. This category can also include plastic shavings from industrial workspaces, often referred to as nurdles. Plastic pellets are often spilled from plastic industries, many of whom are situated along the coast of Lake Erie and in southern Ontario. Finally, styrofoam is a common MP, due to lightweight characteristics and ability to fragment into tiny piece. These MPs can be further identified as either Primary Sourced MPs, or Secondary Sourced MPs. Primary Sourced MPs are plastic particles that were intentionally made small, such as microbeads and pellets, while Secondary Sourced MPs include plastic particles that have fragmented off larger pieces of plastic or synthetic objects (Syberg, et al., 2015, pp. 945-946).

Once in the environment, MPs become a persistent pollutant and the smaller the particle the greater risk they pose "to organism health due to their increased likelihood of uptake, increased surface area for interactions with chemicals and greater number of particles per unit of bulk mass" (Horton, Walton, Spurgeon, Lahive, & Svendsen, 2017, p. 138). Plastic debris of all sizes can harm wildlife through entanglement and ingestion, however, once ingested, MPs can also indirectly harm the organism by releasing dangerous chemicals. Because the chemicals and additives added to plastic polymers are not generally chemically bound, when plastic breaks down "any toxic additives they contain—including flame retardants, antimicrobials, and plasticizers—may be released into the ocean environment" (Betts, 2018). The same is true in freshwater environments, and additionally, "plastics can act like sponges to collect hydrophobic persistent organic pollutants [POPs], such as PCBs" (Betts, 2018). When plastics are ingested these chemicals and POPs can be absorbed into cells and tissues and cause abnormal developments, such as infertility, prevents brain development, and the development of cancers (Browne, et al., 2011, p. 9175). These chemicals and POPs have been seen to bioaccumulate with species (Nelms, Galloway, Godley, Jarvis, & Lindeque, 2018), and researchers are concerned that MPs "could transfer hazardous POPs to marine animals and subsequently humans" (Smith, Love, Rochman, & Neff, 2018, p. 7).

Studies have already discovered the presence of plastic chemicals in humans, and while impacts have not been shown, a correlation has been determined between their presence and an increase in breast cancer, genital tract abnormalities and infertility observed in European and US human populations over the last 50 years (Vandenberg, Hauser, Marcus, Olea, & Welshons,

2007, p. 141). Such discoveries are to be expected as MPs have been found in nearly all consumable items including drinking water (Tyree & Morrison, 2017, p. 1), processed honey and sugar (Liebezeit & Liebezeit, 2013, p. 1), craft beer (Liebezeit & Liebezeit, 2014, p. 1), and within fish sold at markets (Rochman, et al., 2015, p. 1). It will only be a matter of time before researchers provide a definite link between plastics and human health complications.

Microplastics & Lake Ontario

While freshwater MP research is currently in its infancy, Dr. Rochman explains that while the oceans "cover more than 70 percent of our planet, the biodiversity in freshwater and terrestrial systems combined is more than five times greater than in the oceans" (Rochman C. , 2018, p. 29). Rochman's research surrounding MPs in the Great Lakes also demonstrated that "freshwater fish absorb water through their skin and gills; this should lead to different amounts of MP ingestion for identical concentrations of different types of MPs" (Rochman C. , 2018, p. 29). This indicates that freshwater ecosystems may have an increased risk associated with MP pollution than marine ecosystems. Additionally, while plastic pollution in the marine environment has the ability to circulate in open waters, plastic within closed bodies of water such as the Great Lakes will erode at an accelerated rate, as they wash upon shores and in enclosed areas.

The Great Lakes also are a precious water source, and their basin is home 43 million inhabitants in Canada and the U.S. According to Ontario's Great Lakes Protection Act, 2015, the basin "provides for the health and well-being of Ontarians," as the main source of drinking water and a major ecological support for a variety of fish and wildlife (Government of Ontario, 2015). In Ontario, in particular, the Lakes hold important economic, social and environmental benefits as the province's "economy relies upon the water for electricity generation, agriculture, manufacturing and shipping" (Government of Ontario, 2015). Sometimes referred to as the 'land of lakes', the Great Lakes are also entrenched in Ontario's identity, as the Lakes defining natural features offer a plethora of tourist and recreational opportunities for both Ontarians and visitors (Government of Ontario, 2015). Unfortunately, due to climate change and bad waste management practices, the Great Lakes are vulnerable, and suffer from "cumulative pressures such as development, population growth, loss and degradation of natural features, pollution and

invasive species," which has resulted in the declining health of three of Ontario's four Great Lakes (Government of Ontario, 2015).

Within the Great Lakes, 80 percent of the water pollution consists of plastics and 70 percent of Lake Ontario's pollution consists of microfibers (Lake Ontario Waterkeeper, 2018). A 2016 the Ontario Ministry of the Environment and Climate Change (OMECC) study discovered "up to 6.7 million particles of plastic per square kilometre were found (about 7 per square metre)" in Lake Ontario, "with the highest count occurring in Humber Bay of Toronto" (Ontario Ministry of the Environment and Climage Change, 2016). While the GPGP is constantly growing, these levels are higher that the GPGP levels of 6 million particle per square km in 2012 (Allen, 2012). The OMECC also reported that "greater amounts of microplastics were present after rainstorms, indicating that runoff of debris from the landscape through stormwater is an important source to the lakes" (Ontario Ministry of the Environment and Climage Change, 2016). Unfortunately, this observation was also noted by Environment Canada when they designated the Toronto region as an Area of Concern (AOC) four decades ago (Government of Canada, 2017).

While such levels are alarming, they speak to the fact that several urban rivers flow through Toronto, the most populated city in Canada. However, their proximity to Toronto is not the sole reason for such high levels of MP pollution: the Lake's circulation patterns, may also be a primary contributing factor. During "the summer (May- October) surface water circulation pattern is mainly cyclonic, whereas during the winter months (November-April), the lake exhibits a two-gyre circulation pattern with cyclonic flow in the south and east, and anti-cyclonic flow in the northwest" (Corcoran, et al., 2015, p. 18). Thus when researchers discovered pellets on the shoreline of Humber Bay, their investigation suggested that while Toronto is a likely source of large quantities of waste, the beached debris was also dependent on weather conditions, including heavy rainfall and water circulation patterns (Corcoran, et al., 2015, p. 21).

Primary Sources of Microplastics

MP pollution can derive from a variety of sources however research suggests that "mismanaged waste accounts for plastic released to land by littering and wind-blown debris" (Horton, Walton, Spurgeon, Lahive, & Svendsen, 2017, p. 134), and "land-based sources

including beach litter contributes about 80 percent of the plastic debris" (Andrady, 2011, p. 1597). While data on freshwater MPs, and particularly those in the Great Lakes are limited, research suggests that the freshwater and marine MPs share many similarities, including

> "the types of forces that transport microplastics (e.g. surface current); the prevalence of microplastics (e.g. numerically abundant and ubiquitous); the approaches used to detection, identification and quantification (e.g. density separation, filtration, sieving and infrared spectroscopy); and the potential impacts (e.g. physical damage to organisms that ingest them, chemical transfer of toxicants). Differences between freshwater and marine systems include the closer proximity to point sources in freshwaters, the typically smaller sizes of freshwater systems, [that concentrate the plastic debris] and spatial and temporal differences in the mixing/ transport of particles by physical forces" (Eerkes-Medrano, Thompson, & Aldridge, 2015, p. 63).

However, studies report that the major contributors of in-land plastic pollution include "WWTPs and runoff from urban agricultural, touristic, and industrial areas, as well as shipping activities. Another potential source is sewage sludge that typically contains more MP than effluents" (Wagner, et al., 2014, p. 3). Dr. Rochman asserts that the majority of plastic pollution in the Great Lakes is a released from "storm water runoff through rivers or streams, from WWTPs, or litter blown directly into the lakes", and other sources could include agricultural runoff and maritime debris like fishing gear (Campbell, 2018). The role of surrounding waterways as a source of pollution was highlighted in 2018 when researchers discovered that Toronto's Don River emits around 670 kgs of waste into Lake Ontario annually (Hauen, 2018).

As Lake Ontario is surrounded by municipalities which host inadequate waste management systems which are often overwhelmed with waste, WWTP are considered major sources of the Lake Ontario MP pollution (as was proven by OMECC in 2016). In 2018, it was reported that "in heavy rains, 44 Ontario municipalities still overflow their combined sewer and spill filthy, bacteria-laden sewage into lakes and rivers", and such overflows occurred 766 times in 2017 (Rushowy, 2018). Through the passage of wastewater and stormwater, plastic waste that has been released within household waste, or is blown into public gutters, drains and catch basins MPs are transferred into WWTPs. Unfortunately, most municipalities in Ontario do not have the facilities to capture the MPs and they are often released into waterways, or directly into Lake Ontario. For example, studies also report that "washing clothes made of synthetic fiber can release up to 1,900 microplastic fibers per item or >100 per L of wastewater" (Storck, et al., 2015), and few WWTP have the ability to capture these MPs.

To make matters worse, during heavy rain or flooding WWTP become overwhelmed and all waste is released into the environment untreated. In the days that following such events, Ontario municipalities warn residents to keep away from waterways as they are often too hazardous for human contact. These overspills are especially dangerous because MPs act as a carrier raft for POPs and bacteria such as E. coli and will remain in the water longer. This can also result in the development of toxic algae blooms and in colonization of invasive species. While municipalities monitor public beaches along Lake Ontario, the presence of these dangerous pollutants can not only harm residents, but it can negatively impact tourism and recreational opportunities.

Unfortunately, despite an acknowledgment by researchers that freshwater and marine MP share similarities, "plastic accumulation in lakes remains poorly understood because only a minor amount of investigations have been conducted, and factors such as seasonal changes in surface water currents, locations of urban centers, and river and wastewater input are amplified by the relatively small size of a lake compared with an ocean" (Corcoran, et al., 2015, p. 17). Therefore, Canadian governments must support further freshwater and Great Lake MP research. In the meantime, with the recognition that Ontario waste systems, and more specifically WWTPs are the most likely sources of MP pollution, governing bodies must work to revitalize their waste management systems and the need for SUPs.

Political Plastic Awareness

While there are many stakeholders, including industry and civil society, who have roles to play in mitigating MP pollution, it is critical that governments crack down on waste management systems and work to minimize plastic production and consumption. In a 2015, Dr. Peter Ryan explained that "given that plastic litter is, at least theoretically, a wholly avoidable problem, increased effort is needed to stop the inappropriate disposal of waste plastics through a concentration of education, product design, incentives, legislation and enforcement" (Ryan, 2015, p. 18). It is also the role of the Canadian government to protect the environment, and its constituencies.

According to the Canadian Supreme Court of Justice, environmental protection concerns all levels of Canadian government. In 2018, along with other nations and corporations, Canada

signed the Oceans Plastics Charter at the G7 Summit. Within this charter Canada committed to "move forward toward a more resource-efficient and sustainable approach to the management of plastics, take on a lifecycle approach to plastics stewardship on land and at sea, which aims to avoid unnecessary use of plastics and prevent waste, and to ensure that plastics are designed for recovery, reuse, recycling and end-of-life management to prevent waste through various policy measures" (G7 Charlevoix Summit, 2018). While such a commitment is important, no immediate action has been taken, and the waste continues to be flushed into Canada's waterways and subsequently, into Lake Ontario. The government needs revisit current policies and acts to reflect the harmful pollutants of today, and ultimately enact new or up-dated policies to regulate, monitor and support a society that does not trash the environment.

For instance, environmental organizations such as Greenpeace CA, and the Environmental Defence are urging the government to include "microplastics" a pollutant under the *Canadian Environmental Protection Act, 1999* which would allow the federal government to hold industries and persons accountable for MP-related contamination in waterways and the environment. Such an application can be applied to the *Great Lakes Water Quality Agreement, 2012*, which presently prohibits vessels from dumping waste in the Great Lakes, but the agreement "does not regulate the input of plastic debris into the Great Lakes from land-based sources" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12). As land-based pollution is a proven source of MP pollution, the federal government must work to ensure that this policy is altered, and then exercise the act on industries and commercial and residential buildings that contaminate water sources.

On the provincial level, MPs are recognized as harmful pollutants under Ontario's *Great Lakes Protection Act, 2015*. In fact, under section 7, the act states that the Minister "shall ensure that programs or other actions that will be used to monitor and report on ecological conditions [including harmful pollutants such as microplastics] of all or part of the Great Lakes- St. Lawrence River Basin and that are sufficient for the purposes of improving understanding and management of the Basin are established and maintained" (Government of Ontario, 2015). With parts of Lake Ontario severely degraded, the Ontario government has the ability to monitor industries to reduce MP throughout the supply chain and enforce Extended Producer Responsibility. Such enforcements are expected to come under the province's *Waste-Free*

Ontario Act, 2016 and the environment and individuals that are sustained by Lake Ontario can only hope that the act's strategies are implemented and enforced (Government of Ontario, 2017).

However, governing bodies have also admitted to delaying actions to mitigate freshwater MP pollution due to limited data. In 2017, the International Joint Commission (IJC) stated that "the study of MPs in fresh water systems, and the Great Lakes in particular, is a relatively new compared to the marine environment, and several knowledge gaps exist (International Joint Commission, 2017, p. 2). As such, the IJC has called for additional understanding "of the sources, abundance and distribution (spatial and temporal) of MPs in the environment; the transport patterns to and within the Great Lakes; the rates and mechanisms by which different plastic debris degrades; the bioaccumulation of plastics and associated contaminants in food webs and their potential toxicological consequences; and the potential impact on human health from exposure to microplastics" (International Joint Commission, 2017, p. 2). Through government funding, researchers and universities must be supported to develop further freshwater MP research, as a better understanding of these plastics will allow more government officials to support bans.

Importantly, however, although more information would certainly be of some benefit, the environment and waterways within Canada's borders cannot wait for federal and provincial action, and as waste management comes under the role of Canada's municipalities, they have the greatest opportunity to mitigate MPs pollution. Indeed, existing research has already led to legislative bans of MPs, as "plastic microbeads from personal care products were first reported in the freshwater Laurentian Great Lakes, leading to legislation aimed at eliminating this source of MPs in several regions (including the United States, Canada, and Taiwan)" (Rochman C. , 2018, p. 29). Such an approach to preventing MPs from entering water sources is also important given that the main entry of these microbeads was through WWTPs, that as noted above, are unable to capture MPs. While the *Great Lakes Protection Act, 2015* identifies MPs as harmful pollutants and Canadian WWTPs "are currently not required to monitor microplastics in influent or effluent streams" and "many WWTPs in the Great Lakes region are not equipped with such treatment systems [to capture MPs]" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12). To effectively capture MPs requires the adoption of advanced filtration within WWTPs, such as

"fine- or micro-screens, microfiltration, sand filtration, or mixed media filtration" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12).

Although it is clear that MP pollution could be addressed under federal and provincial legislation, it may be more productive to focus on the immediate and primary sources of pollution, which are found within the municipal level. The powers of Ontario municipalities are granted to them by the provincial government, and all authority these municipalities have are found within the *Ontario Municipal Act, 2001* (OMA). The most important authority municipalities have are found under section 10 (2) of the OMA, which states that single-tier municipalities are given the jurisdiction to "pass by-laws respecting the… economic, social and environmental well-being of the municipality, including respecting climate change" (Government of Ontario, 2018). This means that municipalities along the Great Lakes have the jurisdiction to ban SUPs if they so desire and enforce regulations to protect these essential freshwater bodies. Under section 23 and section 93, the OMA also provides Ontario municipalities the jurisdiction to ensure that the WWTPs within their community adopt the best available technology and environmentally responsible practices to capture MPs before they enter waterways. If Ontario municipalities can adapt their WWTPs to prevent further damage to Lake Ontario, it will not only strengthen the health of the surrounding ecosystems and minimize the transfer of Ontario waste from entering the Atlantic Ocean but may also encourage other municipalities- within and beyond Canada- to upgrade their WWTPs to combat MP contamination by offering an exemplary framework to protect aquatic environments.

Due to the importance of Lake Ontario and the dangers that resonate from the presence of MP pollution, it is unethical for governing bodies to continue to ignore this crisis. Tackling the MP pollution problem in the Lake requires immediate action and, along with eliminating SUPs, ensuring WWTPs are properly managing wastewater is a critical step municipalities must take to prevent further degradation of the Lake, and the health of the ecosystems that depend upon it.

Conclusion

While researcher and concerned environmentalists continue to explore the impacts of freshwater MPs in Lake Ontario, "technological innovation, societal action, and political interventions need to be taken to mitigate the plastic pollution, which will- in case of inaction-

certainly increase over the years to come" (Lambert & Wagner, 2018, p. 16). It is important that governments act sooner than later, as evidence already demonstrates the numerous negative consequences of MP pollution, including GHG emissions, harm to wildlife and humans, and the colonization of bacteria and invasive species. Waiting for additional research before governments act is unethical, especially when they have the ability through the power of legislation and by-laws to reform waste management systems and eliminate the most prominent type of plastic pollution: SUPs.

Across Canada cities such as Victoria, Vancouver and Montreal have already taken measures to eliminate SUPs and as such they have become environmental leaders. It is time that cities within Ontario, and especially those that border the Great Lakes, mirror these actions and prevent plastic pollution at the source. These actions can come from municipalities, who have the jurisdiction to tackle waste management issues and pass by-laws. Additionally, supporting efforts to raise awareness by means of community cleanups will help Canadian connect with the land and recognize how detrimental reducing plastics can be to the environment. Opportunities to raise awareness may also increase environmental consciousness and encourage more research in the field. However, it is important that municipalities become aware that the time to act is now, for the longer they delay in stemming plastic pollution, the greater the health risks will be for the planet.

Chapter Two: Case Study

City of Toronto and Microplastic Pollution

Plastic pollution is permeating the globe, and has been dubbed "a top environmental problem and is identified alongside climate change as an emerging issue that might affect human ability to conserve biological diversity in the near to medium-term future" by the UN (Eerkes-Medrano, Thompson, & Aldridge, 2015, p. 64). While many believe that this pollution is isolated within marine environments, parts of North America's prized Great Lakes– who host 25 percent of the planet's freshwater- are also ravaged with plastic waste. All manners of pollution are unacceptable, but plastic contamination within water creates a slew of dangers which include the colonization of harmful bacteria and invasive species which can have devasting effects on the health of surrounding ecosystems. All peoples have the right to clean water, and yet the waterfront of the country's largest city, the City of Toronto is 'off limits' at all times as contact with the water may lead to health issues (City of Toronto, 2018). This contamination is likely due to the high levels of pathogens that reside along this city's shoreline.

In 2016, an OMECC study found that Toronto's Humber Bay hosts levels of MPs levels which are equal to, or higher than those found in the GPGP. More recently, research within Lake Ontario, as well as Lake Superior and Huron discovered plastics in nearly all fish sampled (Campbell, 2018). While MP research in the Great Lakes is in its infancy, recent studies suggest MPs have long been residents within the Great Lakes Basin, including Lake Ontario. A 2015 study suggests that MPs began accumulating in the Lake's sediment less than 38 years ago (Corcoran, et al., 2015, p. 21). This data suggests Lake Ontario plastic pollution began in the mid 1970s, correlating with Environment Canada's 1986 decision to designate the Toronto Harbour as an AOC (Government of Canada, 2017).

Environment Canada's decision was supported by data indicating that several centuries of urban development in the area had reshaped the natural environment, and as a result had left Lake Ontario's water quality and environmental health in the Toronto area severely degraded (Government of Canada, 2017). More specifically, Environment Canada stated that "contaminants from stormwater runoff and melting snow from the area's six watersheds create serious impacts in Lake Ontario," as the "overflows of stormwater mixed with raw sewage are a

serious problem following heavy rains in the lower portions of the Don and Humber Rivers and along the waterfront" (Government of Canada, 2017). Additionally, Environment Canada suggested that "spills, road runoff and chemical input to sewers from industries and residences also contribute to poor water quality" (Government of Canada, 2017). Despite developing solutions in 1986 that could mitigate the situation, over thirty years later, the Toronto region remains a designated AOC. According to the State of the Great Lakes 2017 Report, Lake Ontario harbours invasive species and dangerous algae- an indication of MP pollution- which threaten the ecosystems and residents that depend on the Lake's resources (Environmental Protection Agency, 2017, p. 21). The increase in extreme weather and Toronto's increasing population suggests that the city's already overwhelmed waste management systems need to be addressed before the environment and the health of surrounding ecosystems is irrevocably damaged.

Although there are many stakeholders involved with mitigating plastic pollution, governments have an important role in enforcing laws and regulations which can prevent environmental contamination and pollution. According to the Supreme Court of Canada, all levels of government, including municipalities, have "important roles to play in environmental protection and should do so, within their own allowed jurisdiction" (Surtees, 2017). However, waste management and sewage treatment in particular falls under the umbrella of municipal duties in Canada. Municipalities are also meant to work for the best interests of their jurisdiction and protect the residents and environment within their jurisdiction. However, recent reports of large areas of MP pollution in Lake Ontario suggests that residents and species that depend on the Lake's resources are at risk. A recent study found MPs in human stools showed that humans are ingesting plastic (United European Gastroenterology, 2018), and while the impacts of plastics within humans has yet to be determined, research suggests a correlation between the plastics in humans to a number of health issues including obesity, infertility, impaired brain development, and cancer (Vandenberg, Hauser, Marcus, Olea, & Welshons, 2007, p.141). It is widely known that plastic pollution is a major threat to wildlife, and the UN recently reported that marine debris is harming over 800 species (Smith, Love, Rochman, & Neff, 2018, p. 3). The presence of plastics in the environment can also impacts soils and sediment (Forschungsverbund Berlin. , 2018).

As the water source of Toronto's population of 2.8 million, it is the civic duty of the city's local government to protect its residents and the environment from this pollution. This case study outlines ways in which the city can utilize its powers within the *City of Toronto Act, 2006* (COTA), to prevent pollution from entering the waterways within its jurisdiction; revitalize and upgrade its waste management infrastructure to accommodate its residents and the needs of the surrounding environment; and provide the proper avenues to allow the city's residents to successfully use its waste management system.

Toronto's Water Crisis

In 2014, the 5 Gyres Institute released a report which indicated that "an average of 43,000 microplastic particles per square kilometer" are present in the Great Lakes (Toronto and Region Conservation Authority, 2016). This average jumped up to more the 466,000 in the samples taken close to urban centres (Toronto and Region Conservation Authority, 2016). Later this data was expanded by research conducted by the OMECC, who recorded "up to 6.7 million particles of plastic per square kilometre were found (about 7 per square metre) [in Lake Ontario], with the highest count occurring in Humber Bay of Toronto" (Ontario Ministry of the Environment and Climage Change, 2016). According to the OMECC "greater amounts of MP were present after rainstorms, indicating that runoff of debris from the landscape through stormwater is an important source to the lakes" (Ontario Ministry of the Environment and Climage Change, 2016). Once in the water, this plastic pollution provides surface platforms that support the colonization of bacteria and or invasive species (Ballent, Corcoran, Madden, Helm, & Longstaffe, 2016, p. 384), and the presence of these threats is often an indication of MP pollution.

According to the State of the Great Lakes 2017 Report, Lake Ontario is suffering from toxins that can "can impact drinking water safety or can cause gastrointestinal upsets, skin rashes and at elevated levels can be fatal to many organisms" (Environmental Protection Agency, 2017, p. 12). Considered a "nuisance algae", Cladophora is an algae that is reportedly broadly distributed over large areas of the nearshore regions of Lake Erie, Ontario, Huron and Michigan (Environmental Protection Agency, 2017, p. 12). According to the report, the algae,

> "poses many problems including beach and shoreline fouling, clogging of municipal water intakes and unpleasant aesthetics, as well as tourism and recreational fishing impacts.

> There are also significant ecological impacts of excessive Cladophora growth and, when washed up on the shoreline, Cladophora may harbour pathogens and create an environment conducive to the development of botulism outbreaks which pose a risk for fish and wildlife" (Environmental Protection Agency, 2017, p. 12).

Sadly, in November of 2017, the bodies of thirty-one birds washed up on Toronto's Woodbine Beach, located near Ashbridge's Bay WWTP (Harris, 2017). Autopsies reported that the birds died from Type E botulism- often traced to worms that feed on feces- and while this disease was not linked to algae blooms it is extremely plausible that the botulism was a result of Ashbridge's Bay WWTP effluent. The WWTP has a reputation as a major polluter, and in 2011, the International Commission for Environmental Cooperation named Ashbridge's Bay WWTP the number one surface water polluter in North America (Commission for Environmental Cooperation, 2011, p. 39). Unfortunately, two other Toronto WWTP made the top ten, with Toronto's Highland Creek Treatment Plant coming in at sixth, and the Humber Treatment Plant at tenth (Commission for Environmental Cooperation, 2011, p. 39). Aside from the reports of MP pollution in Humber Bay, the waterfront in this area is often debilitated by bacteria. In 2018, Toronto residents were warned to stay out of the water near Mimico Creek and Humber Bay Park East, after toxic blue-green algae was detected. For a better understanding of the link between the pollution from WWTPs to dangerous bacteria, its important to note that Mimico Creek is only 1.8 km from Humber Bay Treatment Plant, and Humber Bay Park East is 2 km from the plant. More recently, these algae blooms demonstrated their toxicity, where a German Shepard in Whitby, Ontario died 24 hours after it swam in the vicinity of the algae (Jones, 2018).

Despite these reports the City of Toronto continues to claim to have "some of the best beaches in the world," which are verified by the Blue Flag Program (City of Toronto, 2018). The restoration of these beaches has been a priority of the city for years, and to date ten of the eleven beaches they monitor are safe to swim in (City of Toronto, 2018). While these eleven beaches are monitored daily from June to Labour day, the water samples are only tested for E. coli bacteria. According to the city, the "standard for beach water quality in Ontario is set by the Ministry of Environment and Climate Change at 100 E. coli per 100 millilitres of water" (City of Toronto, 2018). Swimming in water with E. coli levels greater than these levels can leave people at risk of infections- which can include ear, nose and throat infections, skin rashes, upset stomach and diarrhea- and young children, the elderly, and individuals with weakened immune system are the most susceptible to water borne bacteria (City of Toronto, 2018). As mentioned early, the

city strongly advises against swimming in the Toronto waterfront at any time (City of Toronto, 2018), and warns that "the public should not swim during and after storms, floods, or heavy rainfall," and explains that "cloudy water can be an indicator of high levels of bacteria that may pose a risk to human health" (City of Toronto, 2018). As both the impacts of climate change and Toronto's population increases, sources of freshwater will become ever more sought after. With evidence pinpointing City of Toronto's predominate sources of pollution into Lake Ontario are stormwater runoff, WWTPs effluent, and littler blown directly into the lakes, as well as the dangers of this pollution to the health to all members of the Lake Ontario Basin ecosystem; it is unethical for governments to delay mitigating Lake Ontario's pollution crisis.

Placing Policies on Plastics

While all levels of Canadian government have the authority to create environmental laws, the development and management of waste management system falls within the jurisdiction of municipalities. In Ontario, municipalities are authorized by the OMA however, because the City of Toronto is the most populated city within Canada, and therefore has a slew of unique issues, the city's powers are authorized under its own municipal act; The *City of Toronto Act, 2006* (COTA), which grants the city broad authority to enact its own by-laws. Located on the northwest shore of Lake Ontario, Toronto is home to 2.8 million people, and its boundaries cover 641 km², its shorelines stretch for 138 km (including the bays and islands), and it boasts 307 km of rivers and creeks within the city. However, despite the broader powers that the COTA provides as well as the financial and technological availability of the Ontario's capital, the city's waste management and sewer systems are outdated and are often overwhelmed by the amount of waste produced by its residents.

The first step in preventing plastic pollution from entering Lake Ontario, is stemming the pollution at its source. As much of the pollution entering Lake Ontario in the Toronto Region is released through stormwater and effluent systems it is critical that the City of Toronto examines its WWTP. Unfortunately, WWTP were traditionally designed to manage organic waste, and is not able to treat the various products that consist of plastics or include MPs, tiny plastic particles > 5cm. These MPs pose an array of issues as they emit GHG emissions, can be ingested by wildlife, entering the food chain or sink into the sediment and become a part of the environment (Baldwin, Corsi and Mason 2016, 10377). Due to their size they are almost impossible to retrieve

once lost in the environment, and they compose 90 percent of plastic pollution in the open ocean (Partridge, Acker, & Colwell, 2018, p. 2).

Despite the growing concern around these MPs, and the increasing awareness of their presence with Lake Ontario, neither Canadian nor American Great Lake municipalities have wastewater treatment regulations addressing MP and as such WWTPs within these countries are "not required to monitor MPs in influent or effluent streams" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12). However, they are not only lacking in policies but in the infrastructure to capture minuscule plastic waste. According to Driedger, et al., in order for WWTPs "to effectively remove microbeads, a form of advanced filtration is probably required, for example, fine- or micro-screens, microfiltration, sand filtration, or mixed media filtration" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12). Unfortunately, the majority of "WWTPs in the Great Lakes region are not equipped with such treatment systems" (Driedger, Durr, Mitchell, & Van Cappellen, 2015, p. 12).

Due to the age of Toronto, the city consists of two different sewer systems, the separated sewer system (SSS) and the combined sewer system (CSS). SSS were introduced into younger parts of the city using separate pipes to carry sewage to WWTP and storm sewers carry stormwater (ran and melted snow) directly to nearby waterways (City of Toronto, 2018). Meanwhile, CSS are "prevalent in older parts of the city, in which: one pipe is designed to take both sewage and stormwater to wastewater treatment" (City of Toronto, 2018). Some of these combined sewers were built as long as a century ago and during periods of heavy rainfall, they become overwhelmed and release untreated effluent directly into creeks, rivers and into Lake Ontario. These combined sewer overflow discharges "contain harmful bacteria, pathogens, heavy metals, oils and pesticides, as well as nutrients that can increase algae growth and degrade the health of the Toronto's waterways" (City of Toronto, 2018). According to a recent report, 44 Ontario municipalities still overflow sewage into lakes and rivers, and in 2017 these overflows occurred 766 times (Rushowy, 2018). Having two different systems has added complexities to the city, as new developers have illegally, and perhaps accidently mis-connected residential or commercial sewer pipes to the wrong system.

Other major sources of Lake Ontario pollution stems from general spills, including illegal dumping and street litter. Spills can include "items discharged directly into the environment,

including illegal dumping or even litter that makes its way into water," and "pollutants that incorrectly enter the sewer system through manholes or catch basins" (City of Toronto, 2018). The city asks that all spills be reported immediately, and all industries and businesses are required to notify the city immediately if they have discharged substances into the sewer or the environment and submit a detailed report within five days of the spill and take preventative measures to avoid further incidents (City of Toronto, 2018). Often waste from industrial sites can be released through drains, and such an issue is prevalent amongst plastic pellet producing industries. Some of Canada's major plastic manufacturing companies can be found within the Lake Ontario watershed. These companies produce synthetic resins, fibres and rubbers included PE, ethylene vinyl acetate, polystyrene, polyvinyl chloride, polyacrylamides, polyethylene terephthalate, nylons, latex emulsions, polyesters, silicones" and others (Ballent, Corcoran, Madden, Helm, & Longstaffe, 2016, p. 384). These tiny plastics can easily spill into drains, evade filtration processes and settle along Lake Ontario's shores. Another industrial source of plastic pollution comes from industrial practices of sandblasting and abrasion from plastic articles (tyres) which are often washed down drains in the form of nurdles or microfibers (Storck, et al., 2015).

Aside from waste washed down drains, Lake Ontario plastic pollution also stems from general litter that makes its way into streams and rivers that flow into local waterways from tributaries (City of Toronto, 2018). The city suggests that these waterways collects "pollution and debris from the stormwater runoff process, and through direct littering" (City of Toronto, 2018). Stormwater is defined by the City of Toronto as rain and melted snow, and when it is not absorbed into the ground "it runs off properties, along streets, down storm drains and through a complex network of pipes that carry it into local waterways or, in some cases, wastewater treatment facilities" (City of Toronto, 2018). The city explains that "the combination of an increase in extreme storms and hard surfaces covering the city is resulting in more water making its way into the stormwater system" (City of Toronto, 2018). In 2018, University of Toronto researchers reported that around 670 kg of waste flows through the city's Don River and into Lake Ontario annually. All of Toronto's water sources flow into Lake Ontario, which collectively "drains an area of slightly >64000 km² and is the terminal lake in the Laurentian Great Lakes chain" (Ballent, Corcoran, Madden, Helm, & Longstaffe, 2016, p. 384). Eventually

this water works its way into the Atlantic Ocean, thus the actions of the City of Toronto will not only impact its own residents, but the global, connected ecosystem.

Power to Prevent Pollution

Fortunately, under the COTA the City of Toronto has the authority to decide which waste management companies they partner with, can monitor WWTPs, enforce stronger environmental standards and stormwater fees, develop green infrastructure to capture and naturally filter, and even ban single-use plastics (SUPS). The COTA provides the Toronto "broad powers to pass by-laws regarding matters that range from public safety to the city's economic, social and environmental well-being, subject to certain limitations" (City of Toronto, 2018). Among many issues, section 8 (1) of the COTA provides the city broad authority the city to "provide any service or thing that the city considers necessary or desirable for the public" (City of Toronto, 2018). Additionally, section 8 (2) allows the city to pass by-laws in respect to the economic, social and environmental well-being of the city; the health, safety and well-being of persons; services provided by the city; and animals" (City of Toronto, 2018). Thus, with the power to take responsible action to develop policies and infrastructure to mitigate the waste entering Lake Ontario, it appears action only requires political will.

The negative impacts of plastic pollution to Toronto's economy, environment and society ought to be enough to propel city action. The Lake is a major part of Ontario's economy, tourism and is a source of freshwater for millions. Allowing this pollution to continue defies the purpose of an elected municipal government, as it is their responsibility to regulate the industries within its jurisdiction and protect the environment within their boundaries. It is critical that the city of Toronto uses the tools available under the COTA to their extent to protect the environment and its residents, and once by-laws are created the city must monitor them to ensure that industries are not exploiting and contaminating the environment around them.

One such by-law was created under the COTA is Toronto's Sewer System By-Law. It was created to "protect public safety, the environment and city infrastructure by setting strict limits on what can be discharged into the sewers system and natural watercourses" (City of Toronto, 2018). According to the by-law only rain and melted snow is permitted to enter catch basins- which lead to directly into rivers, streams and Lake Ontario- and "anything other than

stormwater can harm the environment, cause sewer damage and lead to flooding" (City of Toronto, 2018). This by-law must be enforced as nothing prevents general litter from entering catch basins through stormwater. Ideally, the enforcement of Toronto's Littering and Dumping By-Law would prevent some of the general littering, but it is difficult to know how impactful this by-law is. However, if SUPs were banned from the city, a large percentage of general litter would drop.

However, within Toronto's Sewer By-Law is another useful tool; the Pollution Prevention Reporting Program. Toronto is the first Canadian municipality to implement such a program, and it "requires every subject sector industry and every industry that discharges any amount of a subject pollutant to prepare a Pollution Prevention Plan and submit the plan to the General Manager with respect to the premises from which the discharges occurs" (Toronto Water, 2018, p. 4). If all fails, the COTA also allows the city to "establish fines for contravening by-laws of up to a maximum of $100,000, …establish offences for directors of corporations when corporations contravene by-laws," and even inspect industries for compliance with by-laws (City of Toronto, 2018). The Sewer By-Law prohibiting the discharge of litter into catch basins, programs to report spills, by-laws to prevent littering and dumping, as well as the ability to establish $100,000 fines and inspect industries to ensure the compliance of by-laws, waste should not be entering the city's waterways and polluting Lake Ontario. These by-laws can also be supported by Provincial regulations such as the *Ontario Environmental Protection Act, 1990* (OEPA).

According to the OEPA, "it is the duty of the owner or controller of a spilled pollutant to clean up a spill. They must do everything practicable to prevent and eliminate the negative effects from a spill, including restore the natural environment to its original state. If those responsible for a spill cannot or will not respond to properly clean up the spill, the Minister of the Environment, Conservation and Parks has the authority under the Environmental Protection Act to order those responsible to do so" (Government of Ontario, 2018). The OEPA also states that if these spills are high risk and require significant involvement and resources by the province to actively oversee and monitor the cleanup. The Ontario government can recover reasonable costs and expenses that provincial agencies incur to respond to a spill, including any steps taken to ensure those responsible for the spill: prevent or minimize the impacts of contaminants on

human health and the environment, ensure the appropriate steps are taken to restore the natural environment, [and] prevent or reduce the risk of future spills into the natural environment" (Government of Ontario, 2018).

Aside from the Pollution Prevention program, the city has a number of programs and organizations to monitor, fix and restore problems related it stormwater and sewer outflow crisis. For example the City's Outfall Monitoring Program (OMP), which monitors the outfalls- where the storm sewers exit into waterways, inspects and samples the discharge of every storm sewer, frequent monitoring of priority outfalls (areas of known, intermittent concern), and investigates Priority Outfalls to locate and eliminate the source of contaminated flows (City of Toronto, 2018). Managing rain and melted snow is essential to improving the health of our waterways and reducing flooding, and as of 2016, 84 percent of the city had disconnected their downspouts from the sewer systems (Toronto Water, 2017, p. 8).

However, the city had been working towards managing stormwater before the OMP was implemented, as the adopted a Wet Weather Flow Master Plan (WWFMP) in 2003. This program works to protect the environment and water quality in Lake Ontario, and surrounding rivers, streams and other water bodies from stormwater (City of Toronto, 2018). The WWFMP sets out 13 objectives which are divided under the following four categories; Water Qualities in Local Waterways, Water Quality, Natural Areas and Wildlife, and Sewer System (City of Toronto, 2018). A few of the objectives found under the Water Qualities in Local Waterways category include "virtually eliminate toxins through pollution prevention, improve water quality in rivers and the Lake so that they are healthy for swimming, and improve aesthetics" (City of Toronto, 2018). Under the second category the objective to "eliminate or minimize threats to life and property from flooding" (City of Toronto, 2018). While working to redevelop and conserve the wetlands along Toronto's waterfront would not only support the Natural Areas and Wildlife object to "protect, enhance and restore natural features (e.g., wetlands) and functions," but these wetlands could act as natural filters and capture a portion of the stormwater and WWTP effluent, and would then help the meet this categories following objectives to achieve healthy aquatic communities and reduce fish contamination (City of Toronto, 2018). The objectives of the final category, Sewer System, to "eliminate combined sewer overflow sanitary sewage, reduce infiltration and inflow to sanitary sewers, and reduce basement flooding" (City of Toronto,

2018), would all be resolved if the city worked to upgrade their sewer systems and WWTPs, supported the development of green infrastructure (including green roofs to capture rainwater), used current city by-laws and Provincial laws to monitor and regulate the contamination of industries and residents, focus on restoring waterfront wetlands, and if the city banned SUPs.

Finally, with the focused goal of delisting Toronto of the AOC designation given to them by Environment Canada in 1986, the city has teamed up with community groups and partners to develop the Toronto and Regional Remedial Action Plan. Under the management of representatives from Environment and Climate Change Canada, Ontario Ministry of the Environment, Conservation and Parks, Ontario Ministry of Natural Resources and Forestry, and Toronto and Region Conservation, the organization works to restore Toronto's waters, fish, wildlife and habitats (City of Toronto, 2018). It is clear that the City of Toronto has great tools and programs available, and yet the presence of plastic pollution in Lake Ontario remains unmitigated.

Banning Single-Use Plastics

In 2007 the City of Toronto's City Council voted to place a fee on plastic bags, years later, in 2012, the then mayor, Rob Ford suggested that the fee be rescinded as it would cause legal issues. The City Council responded by voting 27- 17, to ban plastic bags all together, calling for the city "to prohibit all City of Toronto retail stores from providing customers with single-use plastic carryout (shopping) bags, including those advertised as compostable, biodegradable, photodegradable or similar" (Morales, 2012). However, months later the Council scrapped the ban from fear of losing lawsuits filed against them by the Canadian Plastic Bag Association and the Ontario Convenience Stores Association. Toronto had other opportunities to stop plastic pollution in 2014 with a movement within City Council to ban plastic bottles and another push for "heathy vending machines" (Goldsbie, 2014). Unfortunately, both of these movements were voted against, robbing the city from another opportunity to be an environmental leader. Instead, other Canadian cities such as Victoria, Vancouver and Montreal have become environmental leaders by banning single-use plastics. With reports demonstrating that that approximately 9887 metric tons (Mt) of plastic pollution enters the Great Lakes annually, with Lake Ontario receiving 1400 Mts (Water Canada, 2016), it would be interesting to know how much waste could have been prevented from entering Lake Ontario, had City Council passed

those bans on SUPs in 2012 and 2014. Despite these missed opportunities, using the policies and authority granted to it, it's never too late for the city to mitigate SUPs, and in 2016 the city began to make moves to address this issue.

In July 2016, the City Council adopted a Long Term Waste Management Strategy (also known as the Waste Strategy), which places priorities on waste reduction, reuse and recycling and "activities that promote resource conservation and reduce environmental impacts" (City of Toronto, 2018). The Waste Strategy directs the city to explore where greater waste reduction can be achieved via: banning of certain packaging or materials, imposing levies, mandating source separation, implementing disposal bans, [and or] developing local Extended Producer responsibility measures (Solid Waste Management Services, 2018). In July, 2018, the City Council directed the City of Toronto's Solid Waste Management Services (SWMS) to "consult with residents and stakeholder groups on single-use plastics and takeaway packaging items for targeted reduction, and solicit input on policy tools; develop a work plan aimed to reduce the use of single-use or takeaway packaging or products; [and] develop a policy to restrict plastic straws in the City of Toronto" (Solid Waste Management Services, 2018) by the end of the first quarter of 2019 (Toronto City Council, 2018). These efforts to reduce SUPs and takeaway items also supports and aligns with work being done at both the Provincial level under the *Waste-Free Ontario Act, 2016* (Legislative Assembly of Ontario, 2018), and Canada's recent commitment under the Oceans Plastics Charter, to mitigate plastic pollution from oceans (G7 Charlevoix Summit, 2018).

The first phase in this process involved a consultation with Toronto's residents, the stakeholders, accessibility boards, and environmental organizations to identify the opportunities to reduce SUPs and takeaway items, and included a public survey to discover which items residents and stakeholders are most interested in addressing, and the preferred methods or approaches to reducing those items or promoting additional reuse (Solid Waste Management Services, 2018). SWMS has promised to review the information gathered from the survey and the consultations discussion, and report back to Toronto's City Council in early 2019. This will be followed with the second phase of the process, in 2019, which will involve specifically focusing on the implementation approaches to tackle the items identified in Phase One.

While this process is still underway, the SWMS has suggested that there are a number of approaches that the City of Toronto can adopt to address SUPs and takeaway items. Under the COTA the city could enforce mandatory approaches that include a By Request By-Law, a Signage By-Law, or a Disposal Ban. The By-Request By-Law would apply to commercial establishments and would allow them to only distribute SUPs and takeaway items such as straws or cutlery upon a customer's request. The Signage By-Law would enforce commercial establishments to post information for customers on how to reduce their use of SUPs and takeaway items. Meanwhile the Disposal Ban would apply to city transfer stations and landfills, place additional fees on loads exceeding a threshold for designated SUPs and takeaway items. Examples of the Voluntary Approaches that include Voluntary Signage, which may involve posting signage to encourage the use of reusable products, or to provide information for customers on how to reduce their SUP and takeaway items consumption. The Voluntary Approaches may also include city waste reduction programs for registered commercial establishments, incentives or rewards, or education and promotion campaigns focused on reducing SUPs and takeaway items. Depending on City Council's decision, the city could adopt a just one or combination of these approaches (Solid Waste Management Services, 2018).

Awareness & Education

Toronto residents produce 10,000 tons of household garbage a week (half a million tons a year) and 200,000 tons of recyclables a year (Wilkins, 2017). Even with the city's 15 waste facilities, general waste is sent to Green Land landfill, in London, Ontario and its Blue Bin recycling program is costing the city millions. The Blue Bin program has been seeing increasing contamination levels, which indicates a few things including: the instructions around the program are confusing; the diversity of plastic material in the city is beyond the city's recycling capacities; or that Toronto residents are not interested in recycling, or do not understand the importance of recycling. Unfortunately, contamination costs are expensive and may reach $9.2 million by the end of 2018 (City of Toronto, Solid Waste Management Services, 2018, p. 2). When waste is not managed properly it is often lost and becomes general litter. Preventing plastic pollution in Lake Ontario means stopping it at the source, and as SUPs are the least likely to be recycled, and are only in use for a limited time, eliminating them should be at the forefront of government action. The movement from City Council to ban straws is important, and their

steps to push the City of Toronto to reduce and ban SUPs will prevent tons of waste from polluting the streets, parks, rivers and streams of Toronto, and from entering Lake Ontario. It will also relieve pressure on Toronto's stormwater and sewer systems, leaving less non-organic waste for the WWTPs to manage.

This consultation has also provided a space for Torontonians to talk about SUPs and takeaway items. SUPs are in fact a hot topic at the moment, and Single-Use Plastics were dubbed the word of 2018, and as of the end October, Toronto's SWMS survey had received around 1300 responses. With only around 10- 12 percent of plastic being recycling in Canada, SUPS are the least likely to be recycled and more likely to contaminate Toronto's Blue Bin recycling. They could also consider alternatives to SUPs, and therefore eliminating them from communities will not slow people down, but instead encourage people to rely on alternatives to maintain their on-the-go lifestyle. Toronto must also work on raising awareness of the importance of reducing waste, using reusables, and recycling, as well as ensure that the Blue Bin program is not complicated, and can accept the products that are widely available. Currently the Blue Bin cannot recycle cannot accept black plastics, straws, cutlery, styrofoam, coffee cups and single use lids. At the moment the City of Toronto does have a website, the Waste Wizard and an app that is dedicated to educating Torontonians on the city's waste programs.

Unfortunately, one of the problems with mismanaged waste in Toronto is that the city and its surrounding municipalities have different waste programs. This is confusing for residents who live in one municipality but work in another. It is essential that the City of Toronto communicates with its neighbouring municipalities. Toronto has the opportunity to develop a management plan and SUP bans that can be adopted by its neighbours under section 60 of the COTA.

Conclusion

The Toronto Region has been a designated AOC for around four decades, and at the time of designation Environment Canada pinpointed Toronto's waste systems as the major source of pollution. With the rise in plastic production, and subsequently the society's dependence on SUPs increasing, plastic pollution in Lake Ontario is reaching levels that rival in the infamous GPGP. Research has documented the environmental harm of plastic pollution in the form of

MPs, and while data on freshwater MP and the impact of MPs on human health are limited, all known information indicates that MPs will have fatal implications on the health of all species.

Plastic pollution is the result of mismanaged waste, and in Ontario waste management falls under the jurisdiction of municipalities. As the City of Toronto is the most populated city in Canada, recognized as the financial capital, and as such is regulated by its own COTA; Toronto has the greatest opportunity to stem the flow of plastic pollution in Lake Ontario. While the city has made steps to regulate stormwater and sewage systems from releasing waste into the environment, these steps have yet to be successful. As such, the most immediate and productive measure to take, would be to adopt a ban on all SUPs. Eliminating these plastics would reduce GHG emissions, decrease harm to wildlife and humans, reduce shoreline bacteria and algae blooms, and minimize the opportunities for invasive species to encroach on Lake Ontario habitat. Cutting out these plastics would also elevate pressure felt within the city's already overwhelmed and outdated waste management systems, and make Toronto an environmental leader, along with Victoria, Vancouver and Montreal. The City of Toronto and Lake Ontario cannot afford for another four decades to pass before the region's AOC designation is rescinded. In fact, as climate change increases, Lake Ontario will become evermore important as a freshwater resource, and thus we must take all measures to protect it.

Chapter Three: Outreach

Cleanups to Raise Plastic Pollution Awareness

On September 8th, 2018, Hon. Catherine McKenna, Canada's Minister of the Environment and Climate Change exclaimed that "our lakes, rivers, oceans and waterways are a big part of Canada's natural legacy. And it's important that we protect these spaces from the growing plastic pollution" (Environment and Climate Change 2018). The statement came days after McKenna launched a national Community Cleanup, in which across the country, Canadians were encouraged to connect with their local MPs to organize community plastic cleanups. However, while cleanups are helpful to raise awareness and tidy up the environment, they are not a long-term solution. Effective plastic pollution prevention entails stopping the pollution at the source, and as around 50 percent of plastic pollution comprises of SUPs (UNEP 2018, 5), such an action would mean banning SUPs entirely. Also referred to as disposable plastics, SUPs are "commonly used for plastic packaging and include items intended to be use only once before they are thrown away or recycled. They include, among other items, grocery bags, food packaging, bottles, straws, containers, cups and cutlery" (UNEP 2018, 2). Banning SUPs not only minimizes environmental damage, but as plastics are comprised of fossil fuels, reduction in plastic production would result in a reduction in carbon emissions. However, while some Canadian municipalities, such as Victoria, Vancouver and Montreal have taken steps to ban SUPs, Ontario municipalities have been slow address SUPs and as such, are delaying an opportunity to become environmental leaders.

Over the last two decades there has been a global push for individuals to recycle their plastic waste, and while individuals do have a role to play in minimizing plastic consumption, recycling can only go so far. With only nine percent of all plastics made being recycled, and with 80 percent of marine plastic being released from land-based sources, it is clear that current waste management systems are not recycling society's waste. There are many stakeholders whose participation and cooperation are necessary to mitigate plastic pollution around the world, and especially within the Great Lakes, including industry members, scientists, academics, and the public (Ivar do Sul and Costa 2014). However, this outreach focuses on the role of corporations who continue to fuel societies consumption with SUPs and rely on this consumption for their own profit.

Cleanup & Brand Waste Audit

Over the past two decades there has been an increasing history of corporations and governments pushing the narrative that plastic products must be recycled, and therefore plastic pollution is the responsibility of individuals. Campaigns to change individual behaviour and encourage consumers to use reusable bags and containers have been supported and pushed by corporations, governments and environmental organizations. However, specific environmental organizations have decided it is time to change and are "campaigning globally to shift the narrative around single-use plastics from one of individual responsibility to one focused on the need for corporations to reduce their production of throwaway plastic packaging" (Kurdi 2018).

On World Cleanup Day, September 15, 2018 this prominent environmental non-governmental organization (ENGO) conducted a cleanup and waste audit across Canada as an ally of the Break Free From Plastics (BFFP) coalition to discover who are Canada's top five polluters. This ENGO chose cleanup sites in the following four locations; Vancouver, Toronto, Montreal and Halifax, and audited the waste to "identify the major corporate contributors to plastic waste polluting shorelines, green spaces and communities" (Kurdi 2018). I was fortunate to be offered a position within this ENGO to lead the cleanup and audit in Toronto. What follows reflects my experience leading this event, the audit results, and a final outreach installation to raise awareness of Canada's Top 5 Polluters.

Toronto's Cleanup Location

Prior to my arrival within the ENGO, the organization had already scouted sights within the city, and the team was leaning towards a site in Toronto's E.T. Seton Park, that had been suggested to the ENGO by another local environmental organization. The organization is a hybrid environmental group and running club that has strong ties to the area, as they have been running in and cleaning the Don Valley Ravine for years. They highlighted one specific spot under the Overlea Boulevard Bridge that was too difficult for their team to clean. The spot centralized on a stormwater gutter that runs from the top of the north-west side of the bridge, down into the park, and into the Don River which was filled with waste. It had accumulated years of organic matter, so the site required a concentrated effort, hardy equipment, and many hands to unclog. While the drainage ditch was designated as the initial cleanup site, as the event

day approached, it was agreed that the cleanup would not only focus on this site but allow participants to clean where they chose within the park boundaries.

Figure 1 Initial Site: Drainage Ditch Clogged With Waste

Figure 2 Initial Site: Underpass of Overlea Boulevard Bridge

E.T. Seton Park is located in Toronto's Thorncliffe district, situated within Ward 26. With the Don River running directly through the park, it is part of the Don Valley ravine system. The location was exciting for a few reasons, because it offered an opportunity for supporters outside of the downtown core to join the ENGO and presented an opportunity for the ENGO to work with a local environmental organization to tackle local issues. The Don River has been the focus of environmental concern within the Toronto area for decades, as it is known for its pollution which flows into Lake Ontario, and a recent report suggested that 670 kgs of plastic waste is released from the river annually. Organizing a cleanup event on the Don River offered an additional opportunity to raise awareness for the pollution that degrades this important waterway.

According to the Toronto Region and Conservation Authority, the Don Valley River watershed covers an area of approximately 36,000 hectares and is one of the most urbanized watersheds in Canada as it supports nearly 1.4 million residents. This expansive river is 38 km in length, flows south from the Oak Ridges Moraine, into the Keating Channel and empties into Lake Ontario. This waterway supports the diverse ecosystems that reside within the Don Valley Ravine, which include nearly 183 different species of birds, 18 terrestrial species, 12 species of fish- including the Chinook Salmon- four types of turtles, seven types of frog and toad and more (Toronto and Region Conservation Authority 2018). These ecosystems depend on the health of the river, and this environment also provides a place for urban wildlife to live away from the dangers and interactions of human activity. While cleaning E.T. Seton Park is not a long-term solution to preventing plastic pollution, but it was an opportunity for participants to connect with the land.

Figure 3 Overlea Boulevard Bridge & The Don River

Team Effort

The ENGO's supporters were eager to engage with the cleanup, and to make this a successful event, the event needed the support of the ENGO's staff and volunteers. Below follows a list of the critical roles that were necessary to fill to ensure the event's success:

Event Coordinator

- Overall coordination and responsibility for the event.

Audit Coordinator

- Responsible for overseeing auditors while they were sorting the trash,
- Provided guidance and support, and
- Ensured that all waste collected was separated into the correct categories; branded trash, recycling, and garbage.

Volunteer Coordinator

- Responsible for tracking volunteers as they showed up, introducing them to the teams, ensuring all volunteers understood their roles, and provided support as needed.

Site Coordinator

- Managed the event's logistics, including gathering materials, and
- Organized the event Set Up and Take Down.

Media Spokesperson

- Coordinated media presence, namely CBC Marketplace, and
- Participated in live-feeds at the event.

Digital Coordinator

- Managed the event's social media onsite,
- Filmed Facebook livestreams, and
- Interviewed participants.

It was important that this event was widely promoted, and so the ENGO's Communications Team utilized social media to encourage as many people as possible to join us through an Eventbrite page and a Facebook event page. This event also relied heavily upon the support and participation of the ENGO's volunteer group, who made and plastered posters on community boards, school and residential buildings in the park's community.

Collaborators

With the goal to engage with a wider audience and invest in local issues, the ENGO decided to collaborate with local environmental organizations. As DMWTD had been involved in the location decision early on, they became our primary collaborator. However, after some additional networking other local ENGOs became collaborators and their support and sharing of resources helped make this event a success. Working with these organizations was also a great opportunity for the ENGO to foster new relationships, and to acknowledge their support, all banners and event material featured their logos. Due to the large turn out and the media presence, these groups also received press coverage.

Event Equipment

Like many of this ENGO's events, the messaging surrounding this event encouraged waste reduction and an avoidance of SUPs. It was important that this event was zero-waste free, and the majority of the equipment used was borrowed or second hand.

Audit Instructions & Checklists

As this cleanup and waste audit was being conducted as part of the BFFP movement, all participants were given instructions and guides as to how the cleanup and audit should be done. This support included webinars, and both waste and brand audit checklists for the event day.

Event Stations

To facilitate the event specific stations needed to be set up. These stations, which can be seen in Figure 4 and Figure 5, are described in detail below.

Welcome Station

- Located at on Thorncliffe Park Drive to direct participants into the park, and
- Two volunteers were stationed here with walkie talkies and water.

Engagement Station

- Overseen by the Volunteer Coordinator,
- Two volunteers were stationed here,
- All volunteers and staff were directed here to sign-in, grab a burlap bag, cotton gardening gloves, and enjoy refreshments, and
- Opportunity for supporters to learn about the event, and more ways to engaged in the ENGO's Plastics Campaign.

Auditing Stations

- Overseen by the Audit Coordinator, and
- Auditors identified and recorded waste using the official BFFP audit checklists

Waste Sorting

- After waste was audited it was sorted into three piles:
    - Branded waste- to be saved and stored at the ENGO's office,
    - Unbranded, clean waste- to be recycled, and
    - Garbage.

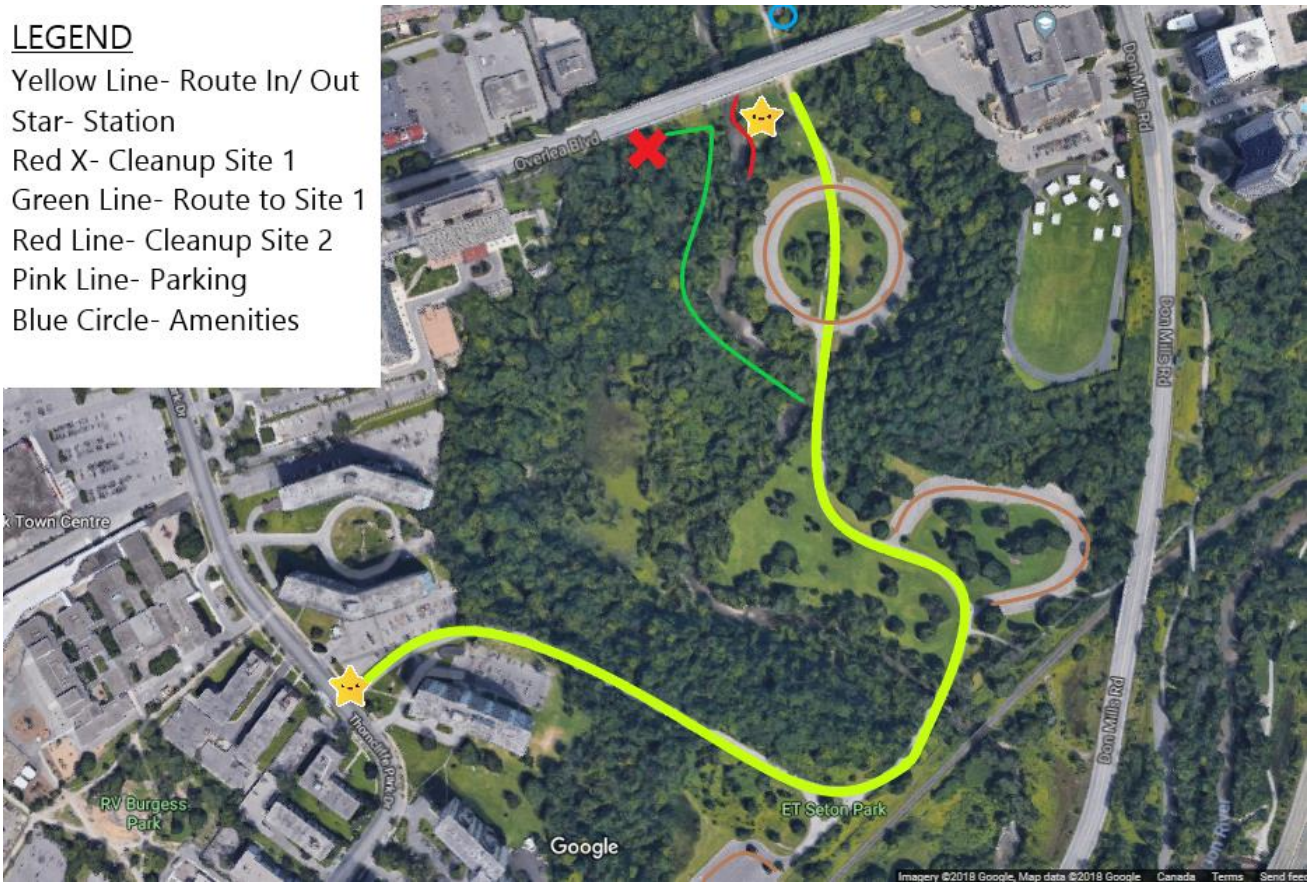

Figure 4 E.T. Seton Park Cleanup & Audit Sites

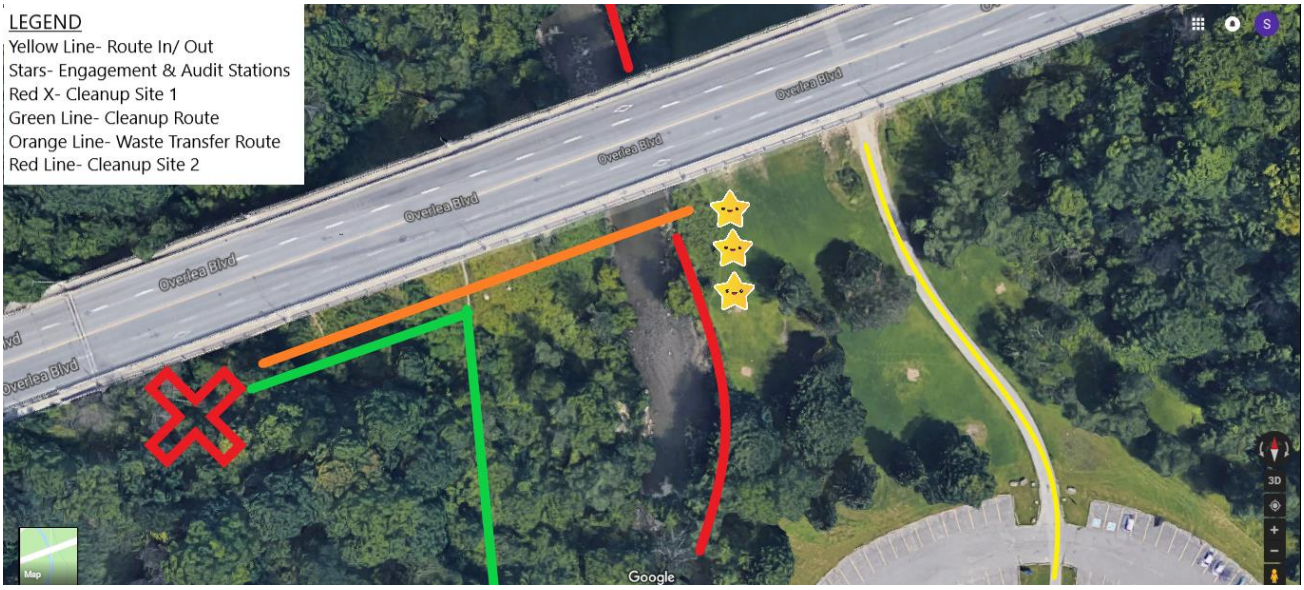

Figure 5 E.T. Seton Park Cleanup & Audit Site: Closeup

Event Training

ENGO's Toronto Local Volunteer Engagement

On the evening of September 6th, 2018, I joined the ENGO's Toronto local volunteer group meeting at the ENGO's Toronto office to invite them to join the event. I presented a PowerPoint presentation which provided a general background on the event, as well as the layout of the stations and the roles. These volunteers played an important role, providing banners, posters, and fulfilled essential roles.

Collaborator Training Event

On the evening of September 11th, 2018, I gathered representatives from the collaborating groups, the ENGO's staff and volunteers to ensure that all members of the team understood the layout, roles, and were trained on the BFFP audit checklists. All information was shared via a PowerPoint Presentation, and members were invited to bring all materials necessary home. Representatives were invited to share this information within their own organizations, to ensure everyone had a clear understanding of the structure of the day.

September 15, 2018: World Cleanup Day

After weeks of preparation, the event day arrived. Organized to run from 10 AM- 4 PM, the event successfully provided an opportunity for new supporters to engage with the ENGO, for the ENGO to foster relationships with other local organizations, and not only cleaned up an important fixture within the Lake Ontario Basin, but allowed the ENGO to examine Canada's top polluters. As a result of the great work done by the ENGO's Communications Team and the support of the event's collaborators, the event was overwhelmed with people. It is estimated that around 160 people joined the cleanup, and as a result of their enthusiasm, over 80 bags of waste were collected along with a mattress, bikes, and a shopping cart. This waste was audited, leaving results to be examined and extrapolated upon in the following days.

Brand Waste Audit Results

In the days that followed the event, the results from each cleanup across Canada were reviewed, and submitted to BFFP, who organized them into a global report. However, amongst the ENGO's Plastics Campaign team the results from the cleanups in Vancouver, Toronto,

Montreal and Halifax were compiled and examined. After careful evaluation the results demonstrated that the Top 5 Polluters in Canada are currently Nestle, Tim Horton's, PepsiCo, The Coca-Cola Company, and McDonald's. Once confirmed, these results were released to the public on October 9th, and this data was illustrated with an infographic which was shared with the public media. This infographic also highlights the most common types of plastic items found and provides quick tips on actions individuals can take.

Similar to the participation in the cleanups, the response to the audit results was overwhelming. The results were covered by over 300 medias include television, radio and print across Canada and corporate representatives from the named companies were quick to respond. However, these responses include previous corporate commitments and goals to reduce plastics by 2025 to 2030. Despite the vague responses from these companies, the awareness of Canada's Top 5 Polluters has become widespread. Armed with the results, the Plastics Campaign team decided to utilize the waste collected to the best of their abilities.

Pop-up Engagement Sculpture

While the Plastics Campaign team was studying the audit results in the days after the event, the Logistics Coordinator connected with a local artist who had a history working with the ENGO to develop an art installation to illustrate the impacts of plastic pollution on Canada's environment. After weeks of intense and creative work, the artist created an eight foot paper-mashé installation of a mother Black Footed British Columbia Albatross feeding its baby chick plastic. The birds sat on a nest of plastic which was composed of both donated plastic and plastic waste collected from the ENGO's cleanups across Canada. The bird was chosen because 90 percent of seabirds ingest plastics at some point, and the Black Footed BC Albatross- a designated species of concern in Canada- are also susceptible to plastic ingestion.

On October 30th, the sculpture was installed in Dundas Square from 10 AM – 5 PM. Likened to a miniature version of New York City's Times Square, Dundas Square is an urban hub that is located across from Toronto's Eaton Centre. Members of the public were invited to take pictures with the installation, and hold signs asking corporations to do more, and were encouraged to share them online to raise further awareness. Additionally, the public were invited to sign a petition asking corporations to do more. Around 400 hundred signatures were received

as a result of the installation, and supporters expressed excitement and interest via emails in the days that followed.

Conclusion

While plastic pollution is a result of mismanaged waste, and thus municipal mismanagement, all members of society are responsible for plastic pollution. It is important that society recognizes that industries have a major role in the plastic production, consumption and end-of-use. It is irresponsible to create products that are not full-cycle products, and the cleanup and brand audit was an opportunity to place responsibility back on the corporations who are feeding society SUPs. While cleanups are a positive opportunity to raise awareness around plastic pollution, they are also a chance for the public to engage with their local environments and share that connectedness with others.

Focusing the cleanup in and around the Don River in E.T. Seton Park was important as the waste collected would have accumulated in the river and traveled into Lake Ontario, with the risk of harming all and any wildlife it came in contact with. Along its journey, this waste would have begun its fragmentation in MPs and permeate both the water and sediment. However, sharing the brand results from this Toronto cleanups with others across Canada, not only allowed participants to be a part of something bigger than a local cleanup, but allowed the ENGO to raise national awareness of Canada's plastic pollution crisis. The audit results put pressure on Canada's Top 5 Polluters, forcing them to respond and feel the pressure of Canadians to rethink their dependency on plastic packaging and SUPs. These efforts were celebrated and reverberated with the albatross sculpture in Dundas Square on Oct 30th and offered an additional opportunity to raise awareness and engage with the wider public on the topic of plastic pollution. This sculpture will be used again at future events, and the ENGO will continue to encourage their supporters to pressure corporations to stop feeding us SUPs, which are difficult to recycle and are more likely to enter water ways and harm the environment.

ABBREVIATIONS

Abbreviations	Explanation
AOC	Area of Concern
BFFP	Break Free From Plastics
COTA	City of Toronto Act, 2006
CSS	Combined Sewer Systems
ENGO	Environmental Non-Governmental Organization
GHG	Green House Gases
GPGP	Great Pacific Garbage Patch
IJC	International Joint Commission
MP	Microplastics
Mt	Metric Tons
POP	Persistent Organic Pollutants
OEPA	Ontario Environmental Protection Act, 1990
OMA	Ontario Municipal Act, 2001
OMECC	Ontario Ministry of the Environment and Climate Change
Outfall Monitoring Program	OMP
SSS	Separated Sewer Systems
SUP	Single-Use Plastics
SWMS	Solid Waste Management Services
UN	United Nations
UNEP	United Nations Environmental Programme
WWFMP	Wet Weather Flow Master Plan
WWTP	Wastewater Treatment Plants

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