

Plastic Film and Packaging Waste Management in Southwestern Ontario: An analysis of current diversion patterns and trends

by

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A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Master of Environmental Studies

in

Social and Ecological Sustainability - Water

Waterloo, Ontario, Canada, 2021

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

ABSTRACT

The production of plastics has drastically grown through the years. In the age of convenience, single use plastics (especially film) have become ubiquitous in everyday life and so has its waste. Plastic waste can be found in unintended places such as in our oceans, animals and even in our food. While plastic film packaging is economically beneficial to many businesses due to their lightweight nature and durability, these same characteristics severely damage our environment and ecosystems from production to disposal. Recycling plastic waste is a common scapegoat used to excuse plastic production, however, not all plastics can be recycled and mismanaged plastic waste poses a great threat to the environment when they blow and pollute surrounding areas. A circular economy must be generated to reduce the amount of virgin plastic film produced, and waste in our environment. To decrease environmental impacts, the entire plastic life cycle needs to be analyzed to determine the true cost of plastic use from fossil fuel reliance in production to environmental degradation from mismanaged plastic waste during disposal. The Canadian government has announced their intent to eliminate single use plastics, however, this is a slow-moving initiative and plastic waste produced to date still remains in the environment and there is no immediate halt on single use plastic production. A gap in knowledge exists when it comes to determining and evaluating an optimal strategy in a Canadian landscape. This thesis will answer the research question “What are the challenges and opportunities associated with a circular economy approach to plastic packaging and film waste management?”.

Global case studies from successful circular economies (UK, Rwanda, Philippines) are examined to identify key criteria that need to be met to encourage this transition. In addition, this thesis will break down popular strategies found in academic literature and industry (reduction of waste downstream, expanding recovery systems and extended producer responsibility) through 6 key stakeholder interviews and further identify how various aspects of each can play a role in the transition towards a circular economy while considering external legislative, social and economic factors. Using key interventions as determined in the Economic Study of the Canadian Plastic Industry Markets and Waste report conducted by Environment and Climate Change Canada (2019) as a guide, interview questions were developed to identify the practicality of each according to industry experts to provide insight on how to best move forward with an implementation plan. By conducting a detailed analysis on the practicality and feasibility of current proposed interventions, barriers towards circularity were identified. The plastic crisis is largely driven by linear business models, and sustained due to the lack of consensus on how to best solve it.

A circular economy requires an innovative sustainable plastics industry which is achieved through support from government, industry and citizens. At the start of life cycle, government intervention plays a key role in determining the amount of plastic waste that circulates within the environment. Numerous actions can be taken to reduce this however, with a majority focus on levelling the playing field between virgin resin producers and post consumer resin producers. Stricter enforcements within industry requiring minimum recycled content in production and funding sustainable alternatives are key actions that need to be undertaken. A circular economy strategy places an emphasis on maximizing the life span of plastics produced already. A focus should be placed on implementing extended producer responsibility at the end-of-life cycle (using economic instruments to deter industry from disposing plastic waste that can be recycled), as well as investing in educational outreach to create public awareness on the detrimental effects of overconsumption to citizens.

This thesis acts as a summary of best practices to adapt within a Southwestern Ontario/Canadian landscape, while adding additional context to plastic film and packaging waste management to public knowledge. While it is up to governments to listen to public needs, without citizen action, there will be nothing pushing legislation to recognize the issue. Advocacy starts with the citizen. Increased public knowledge on the problematic nature of plastic film production, consumption and disposal may spark progressive action. Future opportunities for research should look to address the role of key value chains in the plastic life cycle and fossil fuel reliance.

ACKNOWLEDGEMENTS

First and foremost, this would not be possible without the contributions of each participant in my study. Trying to collect data during the COVID-19 pandemic was extremely challenging, as when I was ramping up my work, the world was slowly shutting down. Each participant not only took time out of their day to chat with me about my research, but also provided additional advice on how I could continue to plug through this process when even their routines were constantly changing and uncertain, and to that I am eternally grateful.

To my supervisor Steve, and my committee, Derek and Brent, I am indebted. Steve, thank you for your constant guidance and support throughout my schooling journey. Whenever there was a roadblock, you always knew what to say to help me maneuver my way around. Thank you for always being there to answer any 'silly' questions I may have had and being there to support me in times of doubt. Even when I was unsure of how to move forward, or if I could even, you never made me doubt my capabilities as a researcher.

Lastly, to all my family and friends that have supported me always and forever. Thank you for letting me vent in times of frustration and celebrating with me for all of life's wins. To my husband Hunter, thank you for always believing in me even when I didn't always believe in myself.

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Chapter 1- Overview

1.1. Problem Context

Plastics are ubiquitous in our environment and plastic waste can often be found in unintended places such as in our oceans, in the stomachs of animals and even in our food (Jambeck et al., 2015; Sicotte & Seamon, 2020). Its lightweight properties, durability and persistence make it a popular and versatile material for a wide range of applications across numerous industries such as food, agriculture, retail, etc. However, these same characteristics that are praised also harm ecosystem services and species right from its production to disposal. While some plastics can be manufactured for durability like for use in construction, a large portion of plastics are produced in high volumes at low costs for short lived purposes such as for use in packaging like plastic carrier bags. The largest market for plastics is in packaging, due to the shift to single use packaging for convenience and economic benefit (Geyer et al., 2017). Plastic packaging alone accounts for over a third of all plastic production in Canada (Government of Canada, 2017; Andrady & Neal, 2009) with plastic film being the fastest growing platform for packaging use (Shedler, 2017). In addition to favourable operating market conditions, the market for plastics has expanded significantly (Government of Canada, 2017).

Although plastics were first invented in the 1850's, synthetic resins used today were popularized in the early 20th century, with mass plastic production only gaining traction in the 1950's. In the past 70 years, mass produced plastic production and waste has managed to cause irreversible damages to our environment. Plastic use can cause severe implications that will haunt us for many years to come through the degradation of natural systems from plastic leakage, contribution to greenhouse gas emissions and harmful repercussions of toxic substances used in production (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2016). It is estimated that about 4.8 to 12.7 million tons of plastic waste from coastal cities have been littered into our oceans to date, with plastic grocery bags being the 5th most littered item on shorelines across 112 countries (Ocean Conservancy, 2017) and plastic packaging accounting for 62% of all material collected in international clean ups (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2016).

With the increasing awareness of plastic litter in the environment, Canada has announced its plan to ban single use plastics as early as 2021. This ban will target problematic plastics that are often not recycled, or cannot be recycled such as plastic carrier bags, straws, stir sticks, six pack rings, cutlery and food ware (Environment and Climate Change Canada, 2020). Currently, there are multiple single use plastics bans implemented across various municipalities which existed prior to the announcement of the federal ban. Most of these bans include plastic bags.

While Canada has announced its intent to move towards a low plastic waste future with the ban of single use plastics, plastic waste management is a complex multi-faceted issue that will require more than legislation. It also requires more than just improved recycling efforts. There have been strategies outlined in academic and popular literature over the last decade looking to minimize the impact of single use plastic waste, such as encouraging the reduction of plastics production and waste downstream (Jambeck, et al., 2015; Hopewell, Dvorak, & Kosior, 2009), expanding recovery systems (Jambeck, et al. 2015) and introducing extended producer responsibilities (Lindhqvist, 2000). Many strategies are tied to a more systematic approach – the circular economy (Stahel, 2016; Esmailian, et al., 2018; Nielsen et al., 2019; Geissdoerfer et al., 2017).

The concept of a circular economy stems from the idea that the earth is a closed, circular system with natural resource yields that act as inputs for production and consumption, eventually becoming sinks for waste outputs. Geissdoerfer et al. (2017) defines a circular economy as “a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops”, and one that can be achieved through “through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling”. A circular economy strategy can be used across multiple sustainability applications. The Canadian government has interpreted a plastic circular economy to be one that will seek to minimize the use of raw materials, maximize the useful life of materials and other resources through resource recovery, and minimize waste generated at the end of life of products and packaging (Government of Ontario, 2020). From the EU Action Plan for a Circular Economy (2018) to the CCME: Canada-wide Action Plan on Zero Plastic Waste (2019), many federal reports have been published to look at implementing initiatives to move towards a circular economy as a means to

manage plastics in the environment. A Canadian “zero plastic waste” future has focuses on prevention, improved collection and recovery methods (CCME, 2018). However, even if a single use plastics ban were to be enforced immediately, there needs to be a plan to reduce use of plastics when and if possible, explore and use more sustainable alternatives, and address the legacy plastics, i.e. the billions of tonnes that exist already.

The global plastic crisis is considered a “wicked” problem (Nielsen et al., 2019), with a large issue being no unified response to the plastic crisis or centrally recognized authority to ultimately define priorities. While plastic film can still be considered essential in certain circumstances (i.e. health services, transportation, food protection), the overabundance of plastic film products for convenience purposes and mismanagement of such is a large driver against the fight for environmental protection. Dynamics within each urban or rural region is unique and is considered a complex social-technological system that operates with its own infrastructure for food, water, waste management, etc. Sustainability within communities will be successful if designed with critical insights on the way that citizens interact with infrastructure within it, as well as how they value it. Each system can be divided according to decision maker (either systems built through collective decisions from public policy, or systems built by individual decisions of each citizen). Waste management largely relies on the latter, as waste generation rates will vary depending on the individual (Esmaelian et al., 2018).

As waste management is both largely a localized issue and one that is easily influenced by unique socio-economic climates, this thesis will start by narrowing down the focus within Southwestern Ontario to investigate how the transition to a circular economy will be the most optimal solution to tackling the plastic crisis in Canada. It will identify best practices for plastic waste given current societal dependence of film (i.e. health services, convenience purposes, transportation, etc.), the uses of single use plastics in a Canadian context, both global and national strategies in action for the elimination and management of such, as well as challenges with managing plastic film throughout the entire life cycle. By keeping the following factors in mind when considering a transition to a circular economy in combination with economic, legislative and social influences present throughout the entire plastic life cycle, we can determine how a circular economy effectively tackles the plastic crisis versus current well-known initiatives such as market-based

incentives or bans. A circular economy is considered a well rounded and ideal solution when it comes to managing plastics that integrates multiple waste reduction and management strategies.

Reports such as the Ocean's Plastic Charter (2020), Economic Study of the Canadian Plastic Industry, Markets and Waste (2019), Canada-wide Action plan on zero plastic waste Phase 1 (2019) and 2 (2020) and A Proposed Integrated Management Approach to Plastic Products: discussion paper (2020), discuss various aspects of popular recommendations surrounding the ideas of reduction of waste downstream, expanding recovery systems and introducing extended producer responsibility, and the role of each in eliminating plastics within the environment. Each report contributes to the development of a national policy to help tackle single use plastics for a "zero plastic waste" future. A national strategy will still have to ensure careful analysis and planning as to how each province or region will address the issue of single use plastics. Outlining the various challenges and opportunities that lie within respective socio-economic climates prior to the development of an overarching national implementation plan can give greater insight as to what may work best. A visible focus for eradicating some single use plastics use is the elimination of plastic bags. This can be seen in various initiatives encouraging the reduction of plastic film use, such as a plastic bag fees at grocery stores, encouraging use of mesh produce bags or reusable container programs.

With the alarming amounts of plastic litter in our environment and the tightening of foreign environmental policy restricting the export of plastic waste, there is an urgent need to create a sustainable plastic film and packaging waste management strategy in Canada to reduce the amount of plastic waste in our landfills and environment. The amount of plastic waste that circulates within our economy is affected by current market conditions, and low value plastics such as film and packaging that are unable to find domestic markets in Canada will be exported or landfilled. While the blame for plastic litter is often placed on developing countries that lack proper waste management infrastructure, the reality is that these countries have long served as dumping grounds for the world's plastics and are used as scapegoats for the world's plastic crisis, even when the origin of the plastic waste from the leakage comes from North American sources (Nielsen et al., 2019). A common destination to send low value plastic waste in the past was China. However, the implementation of China's National Sword restricting low quality incoming material has since

put a hold on China as a top export market. This policy can serve as an opportunity to redesign business as usual for global recycling efforts.

Instead of the linear movement of plastic from production to disposal, there is an opportunity to encourage innovation in within the plastic life cycle to close the loop at the end of life and encourage a circular economy. The implementation of higher quality inputs designed for recyclability can reduce the amount of virgin resources used for production. Improved infrastructure can allow for higher processing capacities to recycle waste into post consumer resins domestically, instead of relying on a single country to process all inputs. While arguments can be made that new restrictions may encourage increased investment to improve domestic recycling capabilities and markets, it is estimated that about 110 million tonnes of plastic waste will be displaced by 2030 due to this change in legislation (Ritchie, 2018). Countries have opted to export their plastic waste elsewhere, merely reinventing the wheel rather than innovating sustainable solutions.

Single use plastics remain a problematic material. The production, consumption and disposal of plastic film especially continues to be the epitome of a “zero plastic waste” future. As plastic film and packaging waste management is an integral aspect of tackling the plastic crisis at the end-of-life cycle, failed to be addressed in any plastic waste studies is the further exploration of societal plastic dependence throughout the entire life cycle. People consume plastic, they are motivated and probably persuaded to use it, industry generally embraced its use; the elements are known but the gap is which of these are bigger influences and how does one change attitudes. **This gap in knowledge is prevalent when it comes to determining and evaluating an optimal Canadian plastic film and waste management strategy, and even more so in a Southwestern Ontario landscape that looks at all economic, legislative, and social influences throughout the entire plastic life cycle when considering the transition to a circular economy.**

This thesis will draw attention to existing barriers to effective film recycling that upon the end-of-life cycle can ultimately impact the transition to a circular economy. A reflection of international policies regarding plastic film and packaging waste management can serve as a guide to identify strengths and weaknesses to each strategy for implementation in a Canadian landscape. The impact of national and

regional by-laws both globally and in Canada such as plastic bag bans or levies in changing behaviour can serve as a reference point for the potential outcome of the federally implemented single use plastics ban coming into effect as early as 2021. Comparisons between current plastic film waste management policies in place both nationally and internationally, as well as impact to markets and society can serve as case studies to identify any gaps for effective execution. The EU Action Plan for a Circular Economy (2018) serves as an effective national and regional model for circular strategies and the Economic Study of the Canadian Plastic Industry, Markets and Waste (2019) provides valuable key interventions for zero plastic waste in Canada, as a large barrier to effective plastic waste management is largely market motivated. By addressing gaps in knowledge throughout the entire life cycle, this increases the likeliness of moving towards a circular economy which will be necessary for environmental protection.

1.2 Single Use Plastics at end of life: Diversion patterns and statistics

In 1950, global plastic production was around 2 million tonnes per year. In 2015, this number sits at about 381 million tonnes per year (Ritchie, 2018). The demand for plastics is estimated to have a growth rate of 5% per annum due to properties that prove to be valuable in commercialized products such as being easily malleable, lightweight, and durable (Andrady & Neal, 2009). A study conducted by Deloitte and Environment and Climate Change Canada (2019) showed that 87% of all plastic produced will end up in landfills or in the environment, with plastic packaging being accountable for 43% of total plastic waste and only 9% of plastics recycled.

In 2016, approximately 4,667 kt of plastics were introduced to the Canadian market both domestically and through imports. However, 70% of the plastics introduced (approx. 3,268 kt) made their way into the waste stream the same year. 33% of plastics (1,553 kt) produced is estimated to go towards packaging (i.e. film, bottles, etc.). 47% (1,542 kt) of plastic waste that year was attributed to plastic packaging (Table 1) (Environment and Climate Change Canada, 2019).

Table 1: Plastics introduced into Canadian Markets

Total Amount of Plastic Introduced to Canadian Market	4,667 kt
Amount of plastic used for packaging	1,553 kt
Total Amount of Plastic found in Waste Stream	3,268 kt
Amount of plastic packaging in waste stream	1, 542 kt
Percentage of total plastic introduced, found in waste streams	70%
Percentage of plastic waste attributed to packaging	33%

Note. Adapted from Environment and Climate Change Canada. (2019). *Economic Study of the Canadian Plastic Industry, Market and Waste.*

Even with recycling, our global solid waste footprint has grown at an exponential rate. As such, most plastics will either be landfilled, recycled or incinerated. Plastics in landfills have grown from 1% of solid waste by mass to over 10% in 2005 with consumer packaging driving the market for plastics (Jambeck et al., 2017). Most plastics are virgin plastics that will be extracted from fossil fuels, transported, refined and manufactured, only to enter the waste stream shortly after. By 2050, global oil and gas production used for plastic production is estimated to rise to 20% and GHG emissions from plastic production alone threaten the goal of keeping global temperatures from rising above 1.5°C degrees, using 10 to 13% of the remaining carbon budget. Due to poor waste management, 29,000 tonnes of plastic leak into the Canadian environment (Aldag, 2019), and 10,000 tonnes of plastic enter the Great Lakes every year (CCME, 2019). Currently, by 2050 (CIEL, 2019). 99% of plastic products are manufactured using fossil fuels, and 8% of global oil and gas production is used for plastic production (Nielsen et al., 2019).

Plastic production and waste have plagued the environment and moved the world backwards in fighting climate change and reducing green house gas emissions. A zero-waste economy is estimated to prevent 1.82 megatons of green house gas emissions by 2030 (CCME, 2020), and innovation within the plastic and waste management industry shows potential for additional value recovery through technological advances so that plastic never becomes waste.

1.3 Research Purpose and Questions

The versatility of plastics has made it a material of choice for use in healthcare, transportation, food, etc. Through the low cost of plastic production and disposal, in addition to its functionality, plastics

have become ubiquitous in our surroundings. However, not only is the use of plastics in everyday life prevalent in modern society but plastic pollution is found globally, and the persistence of the material continues to plague our environment and ecosystems. Canadians alone use up to 15 billion plastic bags alone each year, with a majority being landfilled or entering the natural environment. One truckload of plastic waste enters the ocean per minute, causing significant harm to ocean ecosystems when birds or sea mammals mistaken plastic waste for food (Government of Canada, 2019). Plastic film continues to be a visual reminder of environmental degradation through unnecessary consumption of single use plastics. This problematic material is hard to recycle, not universally accepted in processing facilities and carries low resale value as a post consumer resin. The difficulties managing plastic film within the industry cause it to be a material that ultimately ends up in the environment as litter or landfilled. Although the Canadian government is taking necessary steps to move towards a circular economy and zero plastic waste future, the reality is that plastic film is a unique challenge with an abundance produced that will stay in our environment for generations to come. An appropriate plastic film waste strategy must be developed to encourage a more sustainable future free from plastic overabundance.

With any movement, it will take some time before any real change can be enacted. With the announcement of a single use plastics ban, the federal government has already noted that it will follow the science and consult businesses before moving ahead further (McKenna, 2019). The conversation must move towards how we can better manage plastic film and packaging waste, to create a circular economy mitigating environmental and economic risks for a more sustainable future. Plastic pollution is a prevalent issue in mainstream media through the visibility of poor waste management, the reliance of plastic on finite non-renewable resources is also an issue to acknowledge. A quick Nexis-Uni search of the key words “Canada plastic crisis” resulted with over 10,000 news articles. However, a search within results displayed of keywords “waste management” and “non renewable” came up with 4,062 and 6,381 results, respectively. This shows that the plastic crisis is well covered in media, however, a deeper understanding of the why plastics are so persistent in our environment may not be. Increasing knowledge of the need to consider environmental sustainability through awareness can encourage lifestyle changes in society that reduces plastic usage.

The issue with plastic does not solely occur at the end-of-life cycle. Not only are the implications of plastic detrimental upon disposal but increasing demand of plastics will contribute to rising green house gas emissions. The creation of a sustainable plastic film management strategy will need collaboration and input from all levels of government, industry and consumers that consider influencing factors throughout the entire plastic waste life cycle to move towards a circular society. While plastic waste management is an essential consideration to manage the waste that is produced to date, identifying underlying motivations to the plastic film and packaging industry and the global dependence on plastic film will help create a sustainable future moving forward.

From the production to disposal of plastics, what stimulates the environment for plastic packaging and film and why is the world so dependent on it? A successful Canadian plastic film waste management strategy will require systemic change throughout the entire plastic life cycle with regional considerations. Without the combined efforts of materials recovery facilities, the public, industrial/commercial sectors and the government, plastic film and packaging litter will continue to plague our natural environments, take up space in landfills, and contribute to growing greenhouse gas emissions. The purpose of this thesis is to add additional context to plastic packaging and film waste management in Southwestern Ontario by identifying sustainable and effective circular strategies. This can be accomplished by addressing the research question: **“What are the challenges and opportunities associated with a circular economy approach to plastic packaging and film waste management?”**.

As waste management is often an issue tackled regionally, any barriers to implementation and pain points can be specified geographically to ultimately help piece together an overarching national strategy to fight the plastic crisis throughout the entire life cycle. An appropriate road map for Southwestern Ontario requires a combination of inputs from Canadian industry experts and key stakeholders with reference to what has already been done in other successful circular economies. Criteria for social, legislative and economic change need to be identified to determine what is feasible in a Canadian landscape, and lessons learned with the implementation of other circular strategies globally can serve as a reference point. When comparing available plastic waste studies and reports, most focus on a single area of concern upon disposal such as impact to the economy, environment or government rather than a combination of all factors

throughout the entire life cycle, prior to making any recommendations (i.e. Economic Study of the Canadian Plastic Industry, Markets and Waste, Canada-wide Action plan on zero plastic waste, Ocean's Plastic Charter, etc.).

A key report highly referenced by the Government of Canada was released by Environment and Climate Change Canada (2019). It highlighted five interventions needed to achieve zero plastic waste in Canada from an economic perspective, how legislation impacts post consumer resin markets as well as how economics may drive societal dependence on film. The five interventions are:

1. Create viable, domestic, secondary end markets
2. Community consensus to plastic collection
3. Support and expand value recovery options
4. Increase efficiency throughout the value chain
5. Extend plastics lifetime to reduce and delay waste generation

- Environment and Climate Change Canada (2019)

While this is a valuable piece of literature that highlights societal and market barriers, **a detailed analysis on the practicality and feasibility of each intervention to both public and industrial/commercial sectors needs to be undertaken.** The first portion of this thesis will look at the concept of a circular economy in general, where Canada currently stands in regard to circular and other waste management strategies (is circularity encouraged?), combined with knowledge gathered from successful implementation of circular strategies globally as a reference point to what approaches can be effective. Knowledge collected in this section can then be used to reflect on what is feasible in a Canadian landscape. Using the interventions as developed by Environment and Climate Change Canada to guide primary data collection, we can identify what barriers currently exist that may hinder the progression towards circularity.

Research objectives for the first portion of this thesis aim to:

1. Identify what strategies are currently present in a Canadian and Southwestern Ontario landscape with reference to other circular strategies and what contributed to their success

2. Identify criteria for change (social, legislative, economic)
3. Fill in the knowledge gaps that exist within current plastic waste management strategies using a life cycle analysis, in a Canadian and Southwestern Ontario landscape.

Research objectives for the second portion of this thesis aim to:

4. Identify barriers to implementation in current plastic waste management strategies

Ultimately, the long-term goal for this thesis is to provide further insight on how to transition Canada towards a circular economy to manage single use plastic and film waste.

Chapter 2- Literature Review: Single Use Plastics and the Circular Economy

2.1 Scope of Single Use Plastics use in the Canadian Economy

In Canada, plastic packaging and film contribute to a \$35 billion plastic industry. Additionally, plastic waste sent to landfills account for lost revenue of \$7.8 billion that could have been regenerated into the Canadian economy had the plastic been properly recycled. The lost revenue opportunity for Canadian recyclers on plastic packaging alone sits at \$3.35 billion based on the amount of material landfilled at the cost of virgin resin. However, a zero-waste economy is estimated to save \$500 million in annual costs related to plastic waste management and clean up and create 42,000 direct and indirect jobs (CCME, 2020).

Film is a low value single use commodity with limited recycling opportunities, prone to leakage in the environment due to its lightweight nature. The lack of ability to recycle plastic film itself is a major barrier to creating a circular economy for plastic film waste (Hopewell, Dvorak, & Kosior, 2009; Reclay StewardEdge, 2013). Many municipalities and material recovery facilities choose to exclude plastic film in curbside collections as it is a hard material to separate from other inputs, causing issues with sorting equipment. Successful mixed plastic recycling would require plastics to be separated with no contamination and clean high-quality materials, both criteria that secondary plastic film inputs are normally not able to meet. Low weight-to-volume ratios of plastic film make it economically unattractive for additional investment in better equipment due to a low rate of return (Hopewell, Dvorak, & Kosior, 2009). Of the 528 kt of film collected throughout Canada and the US in 2014, only 0.8% of film collected came from curbside programs while the rest came from commercial sources. This shows that material availability is not so much an issue as the lack of interested buyers and reclamation capacity from materials recovery facilities. There are currently only two plants in Canada that can process dirty film (Shedler, 2017). Lack of markets for plastic film also limit plastic recyclers from accepting this material (Environment and Climate Change Canada, 2019).

Recycling prolongs the useful life of plastics, but ultimately all plastics produced will end up in the waste stream at some point. The concept of plastic packaging comes with a negative connotation associated with litter, or environmental harm, but plastic packaging has contributed to advancements in

transportation, healthcare, safe food handling, etc. and is a valuable invention with no viable substitution on the horizon. While plastics have played a key role in the development of society, the long-lasting detrimental effects of their waste cannot be disregarded. When consumers are given the choice between virgin plastics or less wasteful options such as recycled or compostable plastics, they will choose the latter if both options are offered at comparable prices (Aldag, 2019). This reinforces the idea that plastic waste is an economic issue.

There is a fundamental disconnect between the intention to reduce plastic waste and economics. The virgin plastic industry is about 30 times the size of the recycling industry in Canada. The affordability of plastics is propelled by subsidies in production and low disposal rates in Canada. Energy subsidies that allow fossil fuel companies to thrive in Canada are a contributing factor to the growing production of plastics (Aldag, 2019). An estimated \$600 million per year of subsidies goes towards fossil fuel consumption and production, ultimately creating an optimal environment for plastic manufacturers (Corkal, Levin, & Gass, 2020). With a favourable operating environment for plastic producers aided by low production costs, and a society that scapegoats excess plastic waste to poor recycling, there is no motivation to innovate or stop production from an industry standpoint. The industry continues to see an annual growth rate of 5.5% with companies mainly based in Ontario, Quebec, and Alberta (Environment and Climate Change Canada, 2019).

The first step to reducing plastic waste would be to reduce plastic consumption overall as outlined by the waste management hierarchy (Aldag, 2019; CCME, 2018). However, this is difficult to accomplish when there is ample supply from manufacturers, lowering the cost of plastic products. A visit to any Canadian retailer or restaurant will likely end with a plastic rather than paper bag for any goods purchased. A quick online search of leading North American distributors for shipping, industrial and packaging materials found that a paper bag costs approximately 18x more than a plastic one with similar dimensions in 2020 (Table 2). The mass production of plastics is often cheaper than environmentally alternatives such as paper, due to the heavy reliance of the oil and gas industry to sustain production (Nielsen et al., 2019). This reliance is even more apparent within the plastic film industry due to limited recycling opportunities. Approximately 4-8% of the world's oil production is directly used to produce plastics, with half going towards feedstock and the other half for the production process (World Economic Forum, Ellen MacArthur Foundation and

McKinsey & Company, 2016). Canadian energy resources accounted for 4% of the world's total production and 23% of total Canadian goods exported in 2019 (Government of Canada, 2020). As Canada is a country with an abundance of crude oil and natural gas resources, any repudiation of support for the industry will likely be met with backlash both from the public whose livelihoods rely on oil and gas, as well as industry itself.

If the demand for petrochemicals, a category of oil and gas that includes plastic, continues to grow, it will account for half of all oil demand between now and 2050. With low natural gas prices, companies are looking to capitalize on by products of natural gas such as ethane, that can be used in plastic production (Gardiner, 2019). If governments continue to invest in fossil fuel infrastructure, there will be an abundant supply of plastic in the future whether there is a strong demand for it or not. If plants are built, producers will continue to run them in hopes of finding a market for all the plastic produced (Gardiner, 2019). Investments in the oil and gas industry in Alberta is estimated to grow ethane demand by 4% even though ethane supply currently sits 17% higher than the average from the last 5 years (The Canadian Press, 2020).

Instead of continuing to rely on non-renewables, the concept of using waste to energy can be one potential strategy to look to reduce waste in the environment as well as fossil fuel production. Using displaced plastic waste can help cover local energy needs and avoid fuel shortages (Tomic & Schneider, 2018).

Table 2: Plastic Bag Prices vs Paper Bag Prices

Plastic Bags

Company Name/Region Served	Dimensions/ Product Code	Quantity per Carton	Min. Price Per Carton	Price Per Bag
Uline (GTA based, serves North America)	7 x 5 x 16" S-6638	3,000	\$86	\$0.028
DunWoodyBooth Packaging (GTA based, serves North America)	8 x 4 x 14" 2A640405	2,000	\$34.60	\$0.017
WR Display (Winnipeg based, serves North America)	8 x 4 x 14" 640405	2,000	\$34.60	\$0.017
EJ Bags & Boxes Inc. (Toronto based, serves Ontario)	7 ¾ x 5 x 15	2,000	\$37.10	\$0.019

GoGoPak (Woodstock based, serves North America)	7 ¾ x 5 x 15 SO	2,000	\$33.02	\$0.017
Average Price	\$0.020/bag			

Paper Bags

Company Name/Region Served	Dimensions	Quantity per Carton	Min. Price Per Carton	Price Per Bag
Uline (GTA based, serves North America)	8 x 4 ¾ x 10 ¼" S-7260	250	\$72	\$0.28
DunWoodyBooth Packaging (GTA based, serves North America)	8 x 4 ¾ x 10 ¼" 1A669106cs	250	\$74.25	\$0.30
WR Display (Winnipeg based, serves North America)	8 x 4 ¾ x 10 ¼" 669106cs	250	\$74.25	\$0.30
EJ Bags & Boxes Inc. (Toronto based, serves Ontario)	8 x 5 x 10 ¼"	100	\$34.55	\$0.35
GoGoPak (Woodstock based, serves North America)	8 x 4 ¾ x 10 ½" 8709725	25	\$14.35	\$0.57
Average Price	\$0.36/bag			

The announcement of the zero-plastic waste initiative is a shift in the right direction. However, funding for projects to fight plastic pollution in Canada fall short in comparison to the amount of funding put aside to subsidize the fossil fuel and plastic industry. Currently, there is approximately \$2 million in funding allocated to the initiative for projects that promote the development of innovative solutions that can help aid in the capture of plastic pollution in the environment (Environment and Climate Change Canada, 2020). This would look to help manage plastics both at the start and end of life cycle by investments in R&D. However, this does not directly impact the secondary plastics market (Government of Canada, 2021). While the government has announced its intent to reduce “inefficient” subsidies, there is no direct interpretation for what an efficient subsidy would entail (Aldag, 2019), allowing them to continue to invest in other areas of fossil fuels quietly.

The current shift in federal subsidies from exploration onto development, infrastructure, and exports is contradictory to progress for a cleaner environment in the long run. Federal subsidies continue to fuel the

virgin plastic industry, regardless of the intention of moving away from single use plastics. Post consumer resin and sustainable alternative manufacturers are at an economic disadvantage against virgin producers as the cost of doing business is substantially higher, leading them to have to charge more. Plastics continue to have a demand in the marketplace as they deliver unmatched benefits that improve overall quality of life and the Canadian economy. If virgin plastics and recycled plastics can serve the same function, businesses will choose cheaper plastic resources to help strengthen their bottom line. Additionally, while plastics can be recycled, recyclers often do not always know what feedstock they are working with. Plastics often contain additives such as fillers or colorants, and certain plastics in combination can ultimately affect the functionality of a product. When in comparison with using oil as a feedstock, with established production and distribution systems, most manufacturers will choose the cheaper, more consistent material. While technology exists to help sort and isolate recycled feedstock, it is an expensive and labour-intensive process that increases the price of recycled products (Sutton, 2009). Without regulation within the industry such as minimum content requirements or further investment that leads progress away from virgin plastics, a circular economy cannot be realized. Redefining plastic waste to become a resource rather than a burden can help conserve resources, protect the environment and help Canada stay competitive globally.

Public and private investments into the fossil fuels help sustain the industry while companies are scrambling to respond to declining demand with climate change awareness growing globally. In Canada, Alberta's growing petrochemical industry continues to invest in projects that will turn oil and gas resources into polypropylene plastic (The Canadian Press, 2020). Currently, about \$31.1 billion is invested in oil and gas, both in public and private sectors as listed under Alberta's major projects page (Government of Alberta, 2021) even though fossil fuel demands are estimated to decrease by 35% over the next 30 years (Canada Energy Regulator, 2020). As the focus deviates from fossil fuels as a source of energy, companies are diversifying and shifting their focus onto an industry that continues to prosper, plastics (Cho, 2020; Gardiner, 2019). Companies such as Dow Inc. and Pembina Pipeline Corp. are just two examples of oil and gas companies approved within Canada to invest in petrochemical facilities to expand plastic production, even in light of the looming plastic bans and anti-plastic movements. With government support reviving a declining industry for the fear of threatening Canadian livelihoods and increasing consumer plastic demand, companies can use plastics as a lifeline to continue operations and stay afloat. This becomes feasible as

the issue of plastic pollution and climate change are seen as two separate issues. Although the production and disposal of plastics contributes to rising green house gas emissions, the key issue with plastics continues to focus on waste management. However, without the consideration of the contribution that both plastic production and disposal has to climate change and environmental degradation, the full extent of the plastic crisis cannot be realized.

2.2. Single Use Plastics in Canadian Legislation

The prevention of plastic pollution remains a collective effort amongst government, businesses and consumers. Given constitutional separations of powers, the federal and provincial governments will need to go beyond the broad national strategic aims to create effective change and reduction in plastic waste. Further, waste management strategies and operations usually are devolved to the municipal level, e.g. counties, regions, towns, and cities. Each of these has different capacities for waste handling and probably experience different types of waste and different types and amounts of plastics. This means that the national strategy will have to ensure that the provinces work to fund local efforts at reducing plastic waste; given the sometimes hostile and petty disputes between provinces and the federal government even in times of crises, the challenge to implement a federal strategy to local circumstances is going to require champions and citizen support that transcend ideologies. That too, seems hard to foresee becoming a reality. If anthropogenic climate change and COVID-19 were not enough to result in ideologies and politics being set aside to solve the crises, plastic waste management strategies may be thwarted. However, plastic waste is such a visible and embarrassing problem, there may be room for optimism.

Both the Ontario and Canadian government have recognized that plastic waste management is an issue. However, legislation plays a far more influential role in encouraging behavioural changes on a larger scale. At a federal level, Canada has committed to banning single use plastics by as early as 2021 and zero plastic waste by 2030 in hopes of achieving a circular economy (Environment and Climate Change Canada, 2020). This comes from Canada's 2018 G7 presidency and the subsequent development of the Ocean Plastics Charter. While not legally binding, the announcement of these targets will help hold the Canadian government accountable for their promises and shows intention (Aldag, 2019). In the vision for a "zero plastic waste future", the federal government will be responsible for the overall design of regulatory

instruments and collaborating with other levels of government to ensure compliance, as well as monitor results and feedback. Direction must be given from a national level to establish consistent standards throughout the country.

The provincial government will serve as visible leaders in developing, regulating and monitoring waste management systems to improve waste diversion (Environment and Climate Change Canada, 2019). At a provincial level, several waste diversion acts have been introduced over the past two decades in order to put the onus on producers to reduce the waste they produce from being landfilled. These acts once focused solely on bulky and hazardous household materials, it has grown to include a clause to slowly reduce and eventually ban single use plastics and packaging. Key laws in Ontario that influence and affect recycling activities are: the Environmental Protection Act, O. Reg. 101/07, O. Reg 102/94, O. Reg. 103/94, O. Reg. 104, R.R.O. 1990, Regulation 347, the Waste Free Ontario Act, Environmental Assessment Act and the Planning Act (Recycling Council of Ontario, 2021). More notably so, the Legislative Assembly of Ontario passed the Waste-Free Ontario Act, 2016 which enacted the following two acts in the process: the Resource Recovery and Circular Economy Act, 2016 and the Waste Diversion Transition Act, 2016.

The Resource Recovery and Circular Economy Act, 2016 was introduced to mandate extended producer responsibility in waste management at the end of life of their products. It held companies accountable for reducing waste produced by their packaging or products, as well as recovering associated resources. The act mainly concerned hard to recycle products such as electronics, tires, batteries, etc. This is why some consumers can see an additional environmental fee when purchasing any of these products. The cost per product varies and is used to help sustain recycling programs for these products that otherwise would end up in landfills. This act revamps what was formerly known as Waste Diversion Ontario into the Resource Productivity and Recovery Authority, an authority that is responsible for implementing and operating the new RRCEA framework. As a result, the RRCEA can establish provincial interest in resource recovery and waste reduction. This ensures that combined efforts by municipalities, ministries and producers stay consistent within policies under this framework (Government of Ontario, 2016).

The Waste Diversion Transition Act, 2016 allows products and packaging currently managed under present waste diversion programs transition into a new extended producer responsibility framework without

interrupting existing access to recycling services. Previously, waste diversion programs only considered about 15% of Ontario's waste stream with the last program being introduced in 2009 (Government of Ontario, 2016). Diminishing capacity in Ontario landfills and pressure from citizens who saw a jump in taxes funding waste diversion efforts forced the Ontario government to pivot in their previous strategy to put more of a responsibility on producers to deal with their waste. To create a circular economy within Ontario, the government realized that more legislative influences had to be considered in order to force the hand of producers.

An amendment of the RRCEA in the form of Bill 82 calls for the ban of single use plastics completely by 2021. Piggybacking off the original framework proposed in the RRCEA, Bill 82 adds more concrete timelines and measurables specifically calling for the immediate elimination of single use packaging (i.e. plastic bottles), single use plastic bags, and the distribution and supply of single use plastics in Ontario by 2025. Bill 82 puts more of a focus on single use plastics for convenience purposes rather than necessity. The ban of single use plastics such as film and packaging should be prepped for by ensuring that there is an accessible replacement.

The management of solid waste including recycling, is a shared responsibility amongst municipal, provincial and federal governments as each level of government plays a different role in the upkeep of waste management systems. Waste management in Canada is regulated primarily on a provincial level and by sector, such as residential or industrial, commercial and institutional (IC&I) (Recycling Council of Ontario, 2021), while the federal government is a critical player in creating standards to reduce the number of plastics that end up in the waste stream. From establishing design requirements for packaging to ensure recyclability to minimum recycled content requirements, the federal government plays an important role in creating a market for recycled plastics and preventing foreign competition that entices recyclers to send plastics overseas. Federal acts mandating product composition and how waste moves both nationally and internationally are managed through the Canadian Environmental Protection Act, Transportation of Dangerous Goods Act and the Canadian Environmental Assessment Act (Recycling Council of Ontario, 2021). When taking the entire life cycle of plastics into consideration, the federal government must play more of a key role in restricting unnecessary plastic production within the country, while the provincial

government must focus on how to best manage plastic waste produced within their respective regions. However, no standardization currently exists within the industry with regards to data collection, plastic packaging composition, recyclability of a product, or waste management programs as this remains a key action still needed to be undertaken on a national level. Most jurisdictions operate their own respective facilities and areas of improvement within the recycling industry will be hard to identify without consistency in data reporting (Aldag, 2019).

While waste management is easier to coordinate on a municipal level, collaboration between all levels of government and industry will be required to help fill in any gaps. Most municipal governments have good intentions, but the reality is that not all will possess the resources needed to carry out an effective waste management strategy (Aldag, 2019). Fragmentation within the recycling industry creates inefficiencies in that drive up the cost of recycling and reduces the value of post consumer resins. Without government intervention and standardization, self-regulation limiting virgin plastic production does not exist within the industry.

Legislation plays a key role in establishing and facilitating efficient processes from production to disposal. However, the lack of data available regarding waste management and the movement of plastic waste within Canada and internationally, acts as a barrier to creating effective circular economy strategies. Currently, the CCME has developed an action plan to achieve zero-waste plastic waste that places priority on addressing plastic waste throughout the entire lifecycle with a focus on product design, collection systems, recycling capacity, single use plastics and domestic markets for recycled material. The federal government must provide guidance and vision through legislation for there to be meaningful changes within the country. While provincial and local governments will play a key role in implementation and ensuring compliance, the shift towards a “zero plastic waste” future will largely fall the responsibility of the federal government.

2.3 Circularity throughout the Plastic Life Cycle

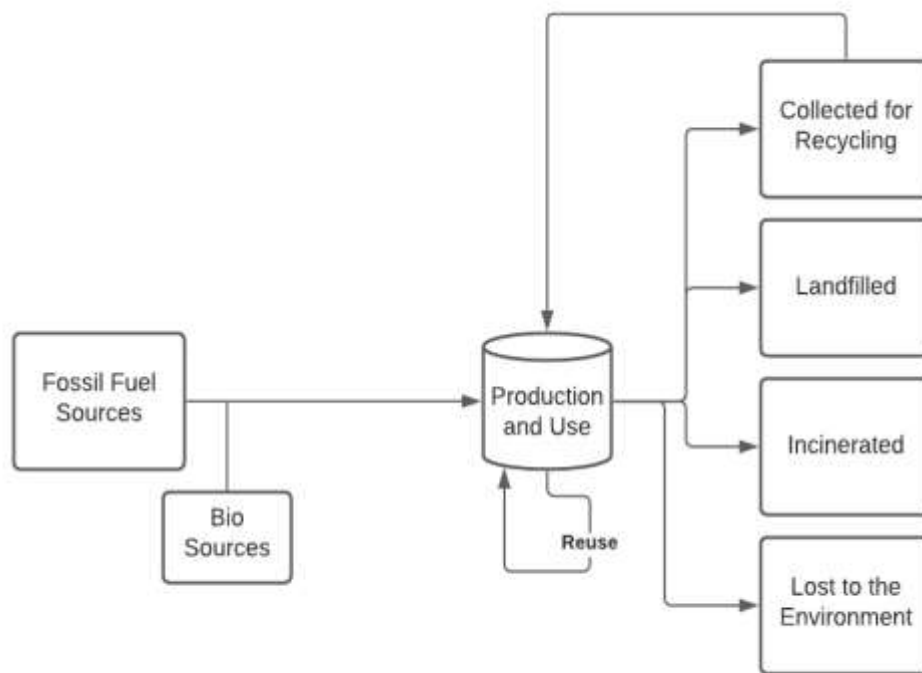
A circular economy would require change in economic logic from production to sufficiency. This would shift mentality from a capitalist viewpoint of bigger, better, and newer, to reusing, recycling, repairing

and remanufacturing what cannot be fixed. Circular economy business models can be grouped in two ways: extending the life of products through repairing, remanufacturing, upgrades and retrofits, or repurposing old goods into new materials such as through recycling (Stahel, 2016). However, the fear of lowering GDP and sales through producing durable goods deters economists and businesspeople alike from the transition to a circular economy. More wealth can be created from requiring consumers to repurchase when something no longer meets their needs. The industrial economy can be categorized in three ways: linear, circular or performance.

The life cycle of any single use plastic (including film) is linear (Figure 1). The linear economy converts inputs into products for sale through a variety of value adding steps. Ownerships and liabilities of products transfers from the producer to consumer at the point of sale (Stahel, 2016). This includes what happens at the end-of-life cycle once a product no longer meets the needs of a consumer. A circular economy will require cooperation from consumers (i.e. changing societal behaviour to focus on repurpose and reuse, rather than disposal), businesses (i.e. manufacturing for maximum durability and recyclability) and government (i.e. enforcing policies that put an onus on producers for responsible production and management of waste, as well as encouraging reuse within consumers). Unfortunately, a linear economy is the most viable option in Canada currently due to economic and policy conditions which allow both cheap production and disposal of plastic material.

A linear economy is unsustainable. The linearity of plastic use gives off the impression that plastic should be cheap. It should be cheap to manufacture, and the material should be even cheaper once it is disposed of. For this reason, recycled plastics are perceived to have a lower value than virgin plastics. Plastics derived from fossil fuels such as polyethylene and polypropylene have low costs, as the manufacturing process has been optimized. However, the complexity of recycling processes often makes recycled plastics a less economical option in comparison to virgin resin manufacturers. The cost of recycled plastics is often too high for consumers to willingly pay (Bucknall, 2020).

Figure 1: Linear Plastic Economy



Note. Adapted from Bucknall, D. (2020).

The plastic and fossil fuel industry are interconnected. Petrochemicals are a primary feedstock for single use plastics, and changes within the fossil fuel industry will ultimately influence the plastics industry as well. Upstream feedstock choices will inadvertently affect what happens throughout the entire plastics life cycle. However, while awareness for the global plastic crisis has grown, there is still little discussion about economic and cultural dependence on fossil fuels (Nielsen et al., 2019) when it comes to their relationship with single use plastics. In the three federal reports published by the Canadian government, (i.e. Economic study of the Canadian Plastic Industry, Market and Waste, Ocean's Plastic Charter, and the Canada wide strategy on zero plastic waste) there is no mention of the reliance of fossil fuels as feedstock. While there is some discussion about using plastic waste as a fuel source from recovery methods such as incineration or through chemical recycling, conversations surrounding the reliance on petrochemicals are limited. The understanding that virgin resin producers have an advantage over secondary plastic producers due to cheap feedstock and lack of secondary markets is emphasized, however, deeper insight into underlying norms and relationships supporting the consumption of fossil fuels within the scope of plastic

consumption is not. Policies limiting fossil fuel usages during production and encouraging the use of secondary resins that have been designed for recyclability will be beneficial in the fight for a circular economy.

Additionally, consumer behaviour is largely environmentally motivated by surroundings, but lasting behavioural changes will be intrinsically motivated (Jakovcevic et al., 2014). While there is the argument that financial incentives can communicate environmental responsibilities and norms intrinsically (i.e. plastic bag levies encouraging consumers to bring their own bag), ultimately it will be up to the consumer to make an active effort in sustaining behavioural changes and closing the intention-behaviour gap. For consumers who may believe that environmental protection is indeed a key responsibility of a good citizen, pricing policies can reinforce this ideology and remind them of this pre-existing belief. While introducing a levy or fee primarily associates waste management to an economic value or financial incentive, legislation can unconsciously motivate consumers of what the “right thing” to do is (Jakovcevic et al., 2014). The availability and accessibility of plastic film ultimately will influence consumption. In certain circumstances, the consumption of single use plastics can be left up to consumers. This is seen in instances such as refusing the use of a plastic carrier bag. However, a large portion of single use plastic film used to package groceries or household goods are decided by the manufacturer or distributor, making our choices limited.

Plastics at the end-of-life cycle are unlikely to be recycled or reused. Poor global waste management is a key driver to plastic pollution and leakage due to plastics being exported out for processing in third world countries (Nielsen et al., 2019). While recycling is a concept that is widely supported throughout the world, it is not enough to tackle the plastic crisis. Global recycling rates currently sit at about 14%, and waste processes on their own are unable to keep up with current rates of plastic production. Improving waste management is considered a priority in transitioning towards a circular economy, however, this feat still requires a combination of waste reduction, improved waste collection, sorting, and overall a better recycling flow. Plastic pollution from marine plastic leakage are intensified for poor countries with inadequate waste management systems, however, these countries are often the dumping grounds for the world’s plastics. While most studies have discussed the global plastic crisis at large through an analysis of public policies or waste management strategies for all single use plastics or

plastics in general, there are few studies that focus on a single problematic item such as plastic bags (Nielsen et al., 2019). Identifying the challenges specifically related to a single kind of problematic plastic can help specify key actions to manage it.

While all single use plastics pose a threat to environmental degradation, some single use plastics may be more complex to address. Grouping all single use plastics to a single strategy may be an oversimplification of waste management strategy. According to Stahel (2016), the objective of a circular economy is to “maximize value at each point in a product’s life”. For this purpose, the value of each plastic item will differ. The price of secondary plastic film is significantly lower than that of other resins. With increasing shale energy investments driving down the cost of virgin plastics and more restrictive export policies, the secondary film market will be affected the most (Schedler, 2018). As a material that is difficult and expensive to process, it is unlikely for materials recovery facilities to invest in film versus other materials when the market for secondary resins for film production are becoming virtually non-existent.

2.4 Common Reduction Strategies

The success of Canada’s recycling industry relies on a variety of **legislative** and **societal** changes, as well as optimal market conditions. Currently, plastic film remains the most visibly problematic single use item with multiple bag bans or levies enforced both within Canada and globally. The low value of plastic film and complexity of recycling processes means that most plastic film produced will likely end up in the garbage, or in the natural environment. With the tightening of foreign policies restricting the exports of plastic waste, secondary resin markets will suffer, leading to more plastic in landfills. A sustainable future with plastics is dependent upon a combination of ideal scenarios presented throughout the entire plastic life cycle that restricts the production and overconsumption of unnecessary plastic film, as well as better waste management.

This chapter will provide a general overview through relevant academic literature of strategies, such as reduction of waste downstream, expanding recovery systems and extended producer responsibility to determine how each strategy can be utilised to help transition Canada towards a circular economy as a means to manage plastic film waste. Moving forward, a review of circular strategies in real life scenarios such as that of the EU, Rwanda and Philippines can be used to identify any common social, economic and

legislative criteria that may have contributed to the success of implementation. Altogether, data collected can help provide valuable insights to transition Canada towards a circular economy and highlight the importance of circularity throughout the entire plastic film life cycle.

2.4.1. Strategy: Reduction of Waste Downstream

Waste downstream will be defined as the movement of plastic film waste towards the end-of-life cycle. Almost all interventions listed above focus on the idea of reducing waste downstream. Landfills are traditionally the preferred method of disposal for plastic waste that fails to be recycled. However, the negative long-term effects of landfill waste to ground water and soil, in addition to the scarcity of available land are increasing concerns in the waste management sector (Hopewell, Dvorak, & Kosior, 2009). Most plastic film produced will be used for packaging and then be disposed of rather quickly, and more commonly, in these landfills. Finding alternatives for single use plastic bags, or plastic film products will ultimately lead to a reduction in plastic film on the planet that may end up in landfills or in our natural systems.

The lifespan of plastic bags and film is rather short in comparison to other plastic products that are used for automotive or construction purposes. Although recycling reduces the impact of plastic film litter without any control mechanisms in place, it does not guarantee proper management of plastic waste. Recycling does not eliminate the need to dispose of plastic waste, but rather prolongs the process towards final disposal. The recycling process will reduce plastic production only if it replaces the need to generate primary plastics completely (Jambeck et al., 2015).

The first step in the waste management hierarchy is to prevent waste to begin with. While global population continues to grow, so does waste generation. Reliance on synthetic plastics continues to rise and a paradigm shift is required to break this cycle for any meaningful long-term changes to occur (Jambeck et al., 2015). The world cannot continue to consume plastics at the current rate without permanent damage to the environment and ecosystems. Plastic leakage into the environment is especially visible in developing countries that lack proper infrastructure to manage it. However, ensuring that there is available infrastructure in vulnerable countries is only half the battle. Foreign policies such as the National Sword are restricting dirty plastic waste imports from developed areas such as the EU or Canada. The implications of this policy have led to plastic waste being displaced in developing nations such as Indonesia, Turkey, India,

Malaysia and Vietnam instead (Katz, 2019). While there have been other mitigation strategies presented such as improved waste management systems, the most effective mitigation strategy is waste reduction.

2.4.2. Strategy: Expanding Recovery Systems

Recovery systems will be defined as the process to which waste is utilized as an input resource, to output a product of value. In Canada, the recycling industry primarily looks to acquire polyethylene terephthalate (PET), high density polyethylene (HDPE) and polypropylene (PP) materials while other kinds of plastics are normally unable to hold their value or be repurposed in a meaningful way (Environment and Climate Change Canada, 2019). However, plastics recovered are normally derived substantially from heavier products such as non-bottle rigid, PET and HDPE bottles rather than PET, HDPE and PP from film products. In Canada, plastic bottles continue to make up about 59% of material collected to be recycled, while plastic film products account for only 19% (CCME, 2018).

Low recovery rates contribute to excessive plastic film waste, as well as lost revenue from repurposed plastic film products. Some common barriers to effective plastic film recycling include the competitiveness within the industry itself between reclaimers and virgin material producers, as well as a lack of awareness from consumers on the recyclability of plastic film (More Recycling, 2018).

The plastic film market is driven by export markets, as most recovered film is sold outside of North America and currently only two plants in Canada can process dirty film (Schedler, 2017). Investments into advancing technologies for materials recovery facilities will increase the number of players in the industry that can handle these processes. Some key factors that drive plastic recycling markets have been identified to be: energy pricing, export demand, transportation costs, and state of collection (Schedler, 2018), and are important influences to consider when implementing any interventions or recommendations.

However, any advances in recovery systems are effective and beneficial only when there are higher diversion rates, efficient sorting processes/reprocessing stages and the absence of 'hard to recycle' plastics (Environment and Climate Change Canada, 2019). Since plastic film cannot be processed by every materials recovery facility, mixing plastics film in with other plastic products can cause issues to arise during

the recycling process. Materials recovery facilities will normally remove film at the start of the recycling process to minimise any problems that may arise downstream during sorting (Reclay StewardEdge, 2013). Sorting and processing plastic film is more complex than other plastic products that are denser in mass. However, the diversion rate overall for all end-of-life plastics remains low in comparison to other materials. The diversion rate for the plastic packaging sector remains sits at approximately 23% in comparison to other sectors such as automotive (100%) or white goods (64%). The low diversion rates of plastics ultimately affects the efficiency of recovery systems and their impact on waste management in Canada. Additionally, most academic and public reports also tend to focus on plastic products or packaging as a whole, which makes it difficult to find updated numbers on a single kind of plastic product. A report conducted by Reclay StewardEdge in 2013 shows that the recycling rate for plastic film (specifically polyethylene carrier bags) sit at 16% in Ontario and 10% throughout North America. A report conducted by Environment and Climate Change Canada in 2019 show that plastic packaging (as a whole, including film) has a recycling rate of 15%, with 11% of end market demands being for plastic film. With current demand and previous recycling rates being fairly similar, it is safe to assume that recycling rates likely have not significantly changed throughout the last decade. The reason for low diversion rates of end-of-life plastics include:

- product design,
- collection mechanisms,
- collections within the industrial/commercial sector,
- infrastructure,
- regulations and
- economic/price influences

2.4.3. Strategy: Extended Producer Responsibility

Extended Producer Responsibility will be referred to as a policy approach that places the responsibility on the producer to reduce the environmental impact of their product throughout its entire life cycle. This can be achieved through implementing initiatives such as take back programs or finding

alternatives/decreasing the use of plastic film in packaging. This is a key principle that looks towards preventive action in environmental policy. EPR seeks to encourage product and process improvement, however, cooperation from legislation plays an integral role in the success of such (Lindhqvist, 2000).

Efficiency of product functions can be improved through shifting responsibility onto the producer (i.e. sourcing more durable materials can enhance the overall function or aesthetic of a product). Key actions from manufacturers can influence the consumption patterns of consumers, as they are the ones providing these product services (Lindhqvist, 2000). This strategy integrates the environmental costs associated with a certain product throughout the life cycle into the price of the product itself. While the purpose of an extended producer responsibility strategy is to put the onus on those who create the waste, producers and government can unfortunately shift the responsibility for managing product waste onto the consumers instead. Some regulatory instruments include take back programs, minimum recycled content, bans, disposal fees, levies, and deposit/refund systems. There are 4 different forms of responsibility first introduced by Thomas Lindhqvist and Karl Lidgren (1990) to the Swedish Ministry of the Environment:

- **Liability:** responsibility for environmental damages caused by a product. The extent of the damage is proven and ultimately determined by legislation. This incorporates the entire life cycle of a product from production to disposal.
- **Economic responsibility:** the producer will be responsible for part, or all of the cost associated with collecting, recycling or disposing of a product. The cost is to be paid by the producer directly, or in the form of a fee.
- **Physical responsibility:** the producer is physically responsible for the management of a product and its effects.
- **Informative responsibility:** the producer is responsible for supplying information on the product, such as environmental properties.

2.5 Current Strategic Applications

With increasing global awareness of plastic pollution, multiple initiatives have been implemented across various countries in an aim to reduce the amount of plastic film and packaging that enters the waste

stream or the natural environment. Common strategies such as bans and levies as means to reduce plastic film consumption have already been implemented globally, as well as within Canada. A review of current and proposed Canadian strategies can give us a better understanding of where Canada lies in regard to current knowledge and understanding of the plastic crisis, in addition to willingness to adopt circular solutions. Other countries such as the EU, Philippines and Rwanda have already taken action to incorporate circular solutions that encourage waste reduction and responsible waste management. A review of strategies implemented by each jurisdiction can paint a more vivid picture of where strengths and weaknesses in different policies lie, as well as give a broader understanding of how socio-economical climates can play a role in the overall success of implementation.

2.5.1. Reduction of use tactics- analysis: Bans and Levies in by-laws

Some common reduction of use tactics are plastic bag bans and plastic bag levies. Bans are by far the most common policy instrument used in the world to reduce plastic pollution (Nielsen, Holmberg, & Stripple, 2019). Although they provide a good start towards moving into a low waste future, they are not an all encompassing or pivotal solution to the global plastic crisis. Bag bans normally target plastic carrier bags, with certain exceptions to bags used to package small hardware or food, or only allowing compostable or bio-based bags. Businesses will not be allowed to carry and distribute plastic bags as part of the federal ban proposed for the end of 2021. However, plastic bag bans are already present in a few municipalities across Canada and province wide in select areas (Table 3).

Table 3: Plastic bag bans enforced in municipalities across Canada

Province	Number of Municipalities Affected
Nunavut	N/A
Northwest Territories	N/A
Yukon	1
Quebec	47
Ontario	2
British Columbia	6
Alberta	4
Saskatchewan	1

Manitoba	4
Newfoundland and Labrador	Province-wide
New Brunswick	3
Nova Scotia	Province-wide
Prince Edward Island	Province-wide

Note. Adapted from “Shopping bag and single-use plastic regulations across Canada” by Retail Council of Canada, 2021 (<https://www.retailcouncil.org/regulations-and-bylaws-on-shopping-bags-in-canada/>)

Each municipality has local control over their rules and enforcements, with most incorporating some sort of levy or minimum post consumer material requirement for plastic or paper bags that are exempt from the ban. As Canada is gearing up to implement a nation-wide plastic bag ban, there can be key lessons learned from current bans put in place. However, bans do not come without their critics. There are arguments that bans are short sighted and tend to oversimplify environmental solutions. Bans have also been said to encourage civil disobedience and illegal activities surrounding plastic consumption rather than providing a long-term solution to plastic pollution (Nielsen, Holmberg, & Stripple, 2019). While bag bans and levies aim to reduce plastic consumption, the implementation of such strategies should be careful not to shift from one single use reliance to another. While banning and taxing plastics will help reduce the amount of plastics in the environment overall, consumer habits should be targeted to encourage reduction and re-use.

Plastic bag levies have also been a common solution presented as an alternative to bag bans or in combination with. Levies impose some sort of taxation for the user of plastic carrier bags. This is normally a small government mandated fee that either goes back to the business to invest in approve initiatives, or more commonly to city funding. Some businesses may choose to impose fees voluntarily. However, there are multiple critics that claim that setting the right price in addition to deciding where the money is spent can be an issue as levies may go towards non-environmental causes. The notion that regulation can simply be reduced to a monetary value is problematic as individuals can be disproportionately affected by levies, as those who may need access to cheaper resources are the ones that are the most impacted negatively.

Nonetheless, both bans and levies have proved to be effective on varying degrees across the globe as countries with either control mechanisms or a combination of both bans and levies have seen a decrease in consumption upon implementation (Table 4).

Table 4: Global Bag Policies

Country/Year of Implementation	Policy Type	Effect (Reduction in Consumption in %)
Denmark (1994)	Tax	66%
Bangladesh (2002)	Ban	No noticeable effect (lack of implementation)
Ireland (2002)	Levy	More than 90%
South Africa (2003)	Partial ban & Levy	Initially 80%, after increased sales 44%, further sales increases expected
Belgium (2003;2007)	Tax & Voluntary Fee	86% between 2003 and 2011, 60-80%
Botswana (2007)	Partial ban & Levy	50%
China (2008)	Partial ban & fee	49%
Hong Kong (2009)	Fee	75%
Washington, D.C. (2010)	Levy	80%
Santa Barbara, CA	Ban on plastic bags, levy on paper bags	89.3% on all types of bags
Wales (2011), Northern Ireland (2013), Scotland (2014)	Levy	Approx. 80%
England (2015)	Levy	85%
Portugal (2015)	Tax	74%

Note. From Nielsen, Tobias & Holmberg, Karl & Stripple, Johannes. (2019). Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect?. Waste Management. 87. 428-440. 10.1016/j.wasman.2019.02.025.

2.5.2. Current strategies in North America/Southwestern Ontario

Canada has announced its intention to eliminate single use plastics across the country. There have been several studies and reports completed on what interventions or objectives are needed to create a low to zero plastic waste future. However, these reports are cluttered and often strategies lean towards one

lens when there are numerous influences to examine as well. Many reports or pledges highlight options that share underlying similarities and overlap one another. Most consider a national framework, but there are no regional frameworks available that focus on a Southwestern Ontario landscape. A list of strategies gathered from three pieces of government literature; The Ocean Plastics Charter, Economic Study of the Canadian Plastic Industry, Market and Waste and the Canada-wide Action Plan on Zero Plastic Waste (including phase 1 and 2).

The Ocean Plastics Charter emerged during Canada’s G7 presidency, bringing together 25 governments and 65 business organizations to date to commit to sustainable approaches aiming to keep plastics out of the environment (Government of Canada, 2020). The Ocean’s Plastic Charter kicks off the Canadian plastic initiative, while the Economic Study of the Canadian Plastic Industry, Market and Waste report gives an in-depth analysis of the Canadian plastic economy and the CCME provides an action plan piggybacking off insights from the previous two reports. The key recommendations highlighted have been compiled in Table 5 below to compare any overarching similarities.

Table 5: Key Canadian Recommendations and Strategies

Recommendation	Source	Related Strategy
Sustainable design and markets	Ocean’s Plastic Charter	Extended Producer Responsibility, Reduction of Waste Downstream
Improvements in waste collection, management and infrastructure	Ocean’s Plastic Charter	Expanding Recovery Systems
Sustainable lifestyles and education	Ocean’s Plastic Charter	Reduction of Waste Downstream
Research and Innovation	Ocean’s Plastic Charter	Extended Producer Responsibility, Reduction of Waste Downstream
Coastal/Shoreline Clean up	Ocean’s Plastic Charter	Extended Producer Responsibility, Expanding Recovery Systems

Create viable, domestic, secondary end markets	Economic Study of the Canadian Plastic Industry, Market and Waste	Expanding Recovery Systems
Community consensus to plastic collection	Economic Study of the Canadian Plastic Industry, Market and Waste	Reduction of Waste Downstream
Support and expand all value recovery options	Economic Study of the Canadian Plastic Industry, Market and Waste	Expanding Recovery Systems
Increase efficiency throughout the value chain	Economic Study of the Canadian Plastic Industry, Market and Waste	Extended Producer Responsibility, Reduction of Waste Downstream
Extend plastics lifetime to reduce and delay waste generation	Economic Study of the Canadian Plastic Industry, Market and Waste	Extended Producer Responsibility, Reduction of Waste Downstream
Information exchange and awareness	CCME- Action Plan	Reduction of Waste Downstream
Waste management from aquatic activities	CCME- Action Plan	Reduction of Waste Downstream
Protect fisheries and aquaculture from litter	CCME- Action Plan	Extended Producer Responsibility, Expanding Recovery Systems
Capture and clean up	CCME- Action Plan	Extended Producer Responsibility, Expanding Recovery Systems
Research and monitoring activities	CCME- Action Plan	Extended Producer Responsibility, Reduction of Waste Downstream
Global leadership	CCME- Action Plan	Extended Producer Responsibility

More specifically, the Ocean’s Plastic Charter emphasizes working with industry using extended producer responsibility strategies to achieve the targets laid out. This strategy specifically looks to analyze the life cycle of plastics to increase reuse and recovery. The charter highlights the importance of extended producer responsibility, establishing performance standards for plastics, creating incentives for a circular economy, assessing current waste management infrastructure needs to improve plastic life cycle management, establishing a plan to address single use plastics, and determining what government tools

would be needed to reduce plastic waste (CCME, 2020). Several aspects such as product design, single use plastics, collection systems, recycling capacity and domestic markets were investigated to see if there a realistic action plan could be put in place.

Using a combination of assumptions and parameters throughout the entire plastic waste management value chain gathered from industry reports, national statistics, literature and industry stakeholders, the release of the Economic Study of the Canadian Plastic Industry, Markets and Waste commissioned by Environment and Climate Change Canada in 2019 provided pivotal information about the plastic market as a whole, identifying strengths and weaknesses in the Canadian economy that could ultimately impact any single use plastic waste management strategies in the future. As a report that is heavily referenced throughout government literature including the Canada-wide Strategy on Zero Plastic waste (including phase 1 and 2) developed by the Canadian council of Ministers of the Environment, all reports commissioned by the Government of Canada ultimately support and intertwine one another. The Canada-wide Strategy on Zero plastic waste places emphasis on reduction of plastic waste and pollution through reuse, repair, remanufacture, refurbishment and recycling of plastic.

The combination of all three reports provided key strategies to be undertaken by the Canadian government to transition towards a low to zero waste plastic future, and conclusively, a circular economy. There are a lot of valuable insights within these reports and great starting points are provided. However, organizing and analyzing each strategy put forth from a unique geographical lens is essential to create both a viable and sustainable national plastic film waste management plan moving forward. Canada's plastic management vision doesn't look to the elimination of all plastics, but rather prioritizing the eradication of problematic plastics, including film. To move Canada towards zero plastic waste, there is a heavy emphasis on plastic at the end-of-life cycle. As such, initiatives to implement extended producer responsibility programs, banning single use plastics, improving recycling facilities, and controlling marine litter have all been explored (Government of Canada, 2020). While the government has acknowledged that single use plastics can be problematic throughout the entire life cycle, the priorities follow the waste management hierarchy with a heavy focus on prevention first to reduce the amount of plastic waste in the environment to begin with.

However, further examination of the detrimental effects of plastic film throughout the entire life cycle, should be undertaken with equal priority. By only outlining the impact that mismanaged plastic waste has on our environmental and human health without considering the catalysts driving plastic production and consumption, only half the problem is addressed. Plastics are a valuable resource that when managed properly can drive innovation and create opportunities in business, helping Canada stay competitive in global markets. However, plastic resources can be detrimental to the environment if there are no controls in place to reduce the amount of unnecessary plastics produced, while also keeping plastic waste out of unintended places.

2.5.3. Strategies in action: EU

Canada is not a pioneer to the zero plastic waste movement. Many countries around the world have already begun to slowly implement production and waste management strategies to reduce their plastic waste.

In 2015, the European commission adopted the EU Action Plan for a circular economy. The strategy focuses on the entire plastic life cycle from production to disposal, rather than just placing an emphasis on halting plastic production altogether. Identifying that the plastic industry was a key driver in the European economy, the Commission sought to create new opportunities in the challenges that arose with production, consumption, and the end of life of plastics. The vision for this new low single use plastics waste future highlighted two priority areas as listed in A European Strategy for Plastics in a Circular Economy:

1. A smart, innovative and sustainable plastics industry, where design and production fully respects the needs of reuse, repair and recycling, brings growth and jobs to Europe and helps cut EU's greenhouse gas emissions and dependence on imported fossil fuels
2. In Europe, citizens, government and industry support more sustainable and safer consumption and production patterns for plastics. This provides a fertile ground for social innovation and entrepreneurship, creating a wealth of opportunities for all Europeans

- (European Commission, 2018, p. 9)

Each vision places a heavy emphasis on collaboration between government, citizens, and market interventions. Without cooperation from all aspects of society, the strategy would not be effective. Below is a table summarizing key interventions and recommendations as put forth by the EU commission to encourage a circular economy.

Table 6: Key Interventions determined by the EU

Areas of Focus	Emphasis on	Government Recommendations	Industry Recommendations
Improving the economics and quality of plastics recycling	Improving product design, boosting recycled content requirements, improving collection/separation of plastic waste	Make use of economic instruments and taxation to encourage the use of recycled plastics, EPR schemes and deposit systems	Improve communication and cooperation across the entire value chain (material and design specifically)
Curbing Plastic waste and littering	Reduce SUP, monitor/curb marine litter, proper definition and innovation of compostable plastics, curb microplastics pollution	Litter fines, encourage beach clean ups, improve waste collection, eradicate non-compliant landfills, introduce deposit refund schemes, national monitoring of marine litter	Promote alternatives to SUP, cross industry agreements to reduce micro plastic in the environment
Driving investment and innovation towards circular solutions	Investment and innovation in the value chain	Use of economic instruments (raise the cost of landfilling and incineration), use of public procurement and funding to support recycling and waste prevention	Investment in R&D, set up private investment funds to help offset detrimental effects of plastic production
Harnessing global action	Key regions that are the largest plastic pollutions (i.e. Asia), support multilateral initiatives on plastic, bilateral cooperation with non-EU countries, support the development of international trade in recycled plastics	Get involved in global conversation to decrease marine litter, take action domestically to reduce the amount of plastic leakage into the environment and increase recycling efforts	Support integrated, cross border initiatives for a global protocol for plastics

Note. From European Commission. (2018). (rep.). *A European Strategy for Plastics in a Circular Economy*.

To ensure success, the EU commission created two platforms in order to keep all collaborators informed and aligned: European Circular Economy Stakeholder Platform and the Circular Economy Finance Support platform, in addition to putting forward ten indicators in four key areas to track progress: production and consumption, waste management, secondary raw materials, and competitiveness and innovation (Table 7). Since 2019, all actions recommended have been implemented and tracked according to the indicators presented, with trends being followed as well to see any notable changes throughout the years. Each indicator is measured by the country, as well as by the EU. To date, there has been evidence of Europe moving towards a more circular economy with increases in revenues generated from circular activities (i.e. recycling, reuse, etc.), jobs related to a circular economy, and percentage of recycled materials used in production (Ellen MacArthur Foundation, 2020).

Table 7: Tracking Indicators determined by the EU

Factor	Indicator
Production and Consumption	EU self-sufficiency for raw materials (%)
	Green public procurement
	Waste generation <ul style="list-style-type: none"> • <i>Generation of municipal waste per capita (kg)</i> • <i>Generation of waste excluding major mineral wastes per GDP unit (kg)</i> • <i>Generation of waste excluding major mineral wastes per domestic material consumption (%)</i>
	Food waste (million tonne)
Waste Management	Recycling Rates <ul style="list-style-type: none"> • <i>Municipal waste (%)</i> • <i>All waste excluding major mineral waste (%)</i>
	Recycling/recovery for specific waste streams <ul style="list-style-type: none"> • <i>Overall packaging (%)</i> • <i>Plastic Packaging (%)</i> • <i>Wooden Packaging (%)</i> • <i>E-Waste (%)</i> • <i>Biowaste (kg/capita)</i> • <i>Construction and demolition waste (%)</i>

Secondary Raw Materials	Contribution of recycled materials to raw materials demand <ul style="list-style-type: none"> • <i>End of life recycling input rates (%)</i> • <i>Circular material use rate (%)</i>
	Trade in recyclable raw materials (tonne) <ul style="list-style-type: none"> • <i>Imports from non-EU countries</i> • <i>Exports to non-EU countries</i> • <i>Intra EU trade</i>
Competitiveness and Innovation	Private investment, jobs and gross value added related to circular economy sections <ul style="list-style-type: none"> • <i>Gross investment in tangible goods (% of GDP)</i> • <i>Persons employed (% of total employment)</i> • <i>Value added at factor cost (% of GDP)</i>
	Number of patents related to recycling and secondary raw materials

Note. Adapted from Eurostat. (2021).

The EU is considered a global leader when it comes to leading the charge towards a zero plastic waste future using a circular economy approach. Their plastic waste strategy in the EU is the most intensive published piece of literature that can be found, with clear goals, implementation plans and measures of success. While other countries and regions have adopted various approaches to keep single use plastics out of their waste stream, there is little data available to help track the success of each regulation or strategy put forward in their respective areas. Some areas may focus on strict bans of plastic film in totality (i.e. Rwanda), while others look to levies to reduce the amount of virgin plastics in their environment and center on reuse ideologies (i.e. Philippines), encouraging a circular economy.

2.5.4. Strategies in action: Review of the Quezon City Bag Levy

The Philippines is the third largest source of marine plastic pollution, with single use plastic waste plaguing waterways causing flooding and adverse weather events (Climate-KIC, 2018). To help curb single use plastic litter, Quezon City, a municipality within the Philippines implemented levies to limit the amount of plastic film in the environment. Prior to implementation, the municipality consulted with businesses to gauge any areas that may be of concern when it came to creating the plastic film recovery system and fees. The levies were not meant to be a revenue generating stream, but rather collected fees went back to

businesses instead of into city funds. The funds collected would then be used towards green initiatives as decided by each business, with a total of \$7.4 million collected to date (Climate-KIC, 2018).

Plastic bags can be brought back into each business, where used bags will be sold off to recyclers and replaced if needed, keeping in the 'reuse' and circular economy mindset. A key part of this strategy lies in marketing efforts carried out by the municipality, as well as each business. Businesses are encouraged to provide incentives for customers who bring their own bags, such as bonus points in loyalty campaigns if present, or even a designated express check out area. This is a key difference in strategy when compared to other plastic bag levies implemented by any governing authority globally. Levies collected where plastic bag fees are enforced by a municipality or country usually will go towards government funds, whereas self-declared levies by businesses are not managed by any other authority with businesses having full reign on how they choose to reinvest the money collected.

To ensure success in Quezon City, a task force was gathered with the city to collect waste data, report compliance, spread awareness, and create educational campaigns. A three-month grace period was granted for businesses to help transition into this new regulation, after which harsh punishments for businesses were given out for non-compliance in fee collections. Businesses are also required to submit quarterly self-monitored reports on bag usage with the purpose of this levy encouraging a switch in consumer behaviour into more of a "reuse" mindset (Climate-KIC, 2018).

Although each plan does not solely focus on single use plastic waste, there are underlying strategies that can be examined further and applied to plastic film and packaging waste management that can help ensure success in future implementation.

In a report completed by UN Environment in July 2018, 192 countries were reviewed to identify what plastic film strategies currently exist in each respective region. Countries that did regulate plastic bags had interventions in place to reduce the amount of film manufactured, distributed and traded, although each law varied in how all-encompassing they are. The most common bag ban enforced was free-retail distribution in 83 countries, followed by manufacturing bans according to thickness and material content in 61 countries. Only 27 countries enacted a tax on the production of bags, and 30 countries charged

consumers a fee at the federal level. Prevalent strategies such as extended producer responsibility in legislation were found in 43 countries, while 51 countries implemented recycling targets specifically for plastic bags. This shows that plastic film waste management awareness is becoming increasingly common in the world. Although each country has their own specific set of laws or strategies to stop plastic bag production at the source or at the end-of-life cycle, the effectiveness of each will depend purely on the socio-economic climate and culture as what will work in one region may not work in another. A combination of multiple strategies seems to be the most effective in enacting changes in plastic film waste management.

2.5.5. Strategies in action: Review of the Rwanda Plastic Bag Ban

The Rwandan plastic bag ban has been highly successful within the country due to limited powers given to producers, manufacturers and businesses which drew little to no resistance. The ban initially started gaining traction in 2003 when the awareness of the detrimental effects of plastic pollution to the environment came to light specifically surrounding the issues of soil pollution, impact to drainage and implications to cows given the large agricultural industry present in the country. Initially, a nation-wide campaign was launched to increase awareness, heavily driven by the Rwandan Government. In 2005, the ban went into effect restricting the import, production and use of plastics less than 100 microns. In 2008, the ban incorporated plastic film in entirety (Behuria, 2021). Legislation was very strict, as smugglers who were caught would receive jail time and random checks in stores and manufacturing plants would be carried out by the government.

While it is still legal to import plastic for packaging, special permission must be granted from the government to do so. These policies were initially developed to align with Rwanda's desire to position itself as a regional environmental leader, and external legitimacy to achieve a services 'hub' economic strategy. Taking the 1994 Rwandan genocide into consideration, the government was still struggling to recover the economy. As a landlocked country, manufacturers are already at a disadvantage due to high transportation costs. This led the government to pivot to the idea that Rwanda can capitalize on services within the tourism sector instead of manufacturing. With this in mind, Rwanda needed to position themselves as a tourist destination that was clean and inviting. In the last decade, tourism services made up almost half of

Rwanda's GDP in comparison to less than 30% in 1994. External legitimacy is linked to securing foreign investments into Rwanda to drive service-based economic growth, and reinforcing the viewpoint that Rwanda is very much so considered an attractive place to visit (Behuria, 2021).

This ban is a good example of using both economic strategy and policy actions to achieve environmental progress. By linking both a desired economic outcome with policy, Rwanda was able to capitalize on the plastic bag ban to reinforce the idea to citizens that keeping the country clean is essential for prosperity. However, disclosure of the compliance rate or influx of illegal bags into Rwanda has not been clarified.

2.6 Criteria needed to move towards Circularity

Areas such as the EU, Philippines and Rwanda have recognized the urgent need for circular solutions to manage plastic waste. Taking note of key actions and respective outcomes from each strategic application can help identify relevant social, legislative and economic criteria needed to create a road map for Canada to transition towards circularity.

2.6.1. Criteria for social change

Throughout the 1950s and 60s, modern society became defined through consumerism and industrial progress. The vision of the future saw increased standards of living and associated buying power with freedom. Over time, society was programmed to see consumerism as the ability to make choices with money. The ability to afford goods and services of your choice became a fundamental class marker and as Canadians started migrating towards urban areas, goods and services were always paraded front and center. Daily exposure either in store, or more recently now through online mediums slowly breaks down buyer resistance. Canadians associate class with standards of living and ownership, things that are visibly on display, rather than how much money they actually have (Liverant, 2018). As the price of goods and services becomes more attainable to the average citizen due to mass production and the rise of credit use, the consumerism present in society is more apparent now than ever.

For a successful transition to a circular economy, there must be collaboration between consumers, government, and businesses. The urgency to shift to a re-use mindset and the desire to consume less will be interpreted differently according to individual. Although policies may be implemented to try and encourage this, if they are the sole driver, governments will have a hard time creating lasting behavioural changes. This can be seen in the case for Rwanda's plastic bag ban. Although the country is deemed as one of the cleanest in Africa due to its strict plastic bag ban, plastic bags are starting to become a valuable commodity on the black market. Instead of the ban inspiring citizens and bordering countries to view plastic bags as a non-necessity, the socio-economic climate became a large driver in creating the perception that these bags can help people escape poverty. Those who were willing to risk prosecution smuggled plastic bags across the border, often making a week's income off just a single trip. Although smugglers caught can be charged with hefty fines or jail time, they often take the risk as most are too poor to pay and will be released without any additional ramifications. Without the want of a common goal to eradicate plastic bag use for convenience, it will always be an issue no matter what political or economic instruments are enforced. However, with the ban of plastic bags, there has been more innovation in product design for bag alternatives, but this is not enough to stop the black market (Ocean Wise, 2017).

The following behavioural theories as outlined by Parajuly et al. (2020) in Table 8 can be used to predict behaviour in response to environmental changes influenced by various social or legislative factors.

Table 8: Environmental Behavioural Theories

Theory	Summary
Rational Choice Theory	Pro-environmental choices are made with intention for maximizing personal benefit. Willingness to act a certain way can be predicted by social norms and what seems to be the most rational choice according to each individual.
Moral Theories	Moral norms are strong drivers of pro-environmental choices. Acts under the assumption that people will value the environment and take on responsibility to care for it. Does not appeal to economic self interest but rather positive self concept, and what an individual may deem to

	be morally correct. Behavioural changes here are more long lasting since they are intrinsically motivated.
Economic Model	Behaviour can be affected by economic incentives. Under the assumption that willingness to pay will be dependent on socio-economic factors. This is found to be an unstable predictor as actions towards the environment are not always directly related to market factors.
Community Based Social Marketing	Behaviour can be influenced by those around you. Marketing efforts that appeal to change behaviour that can benefit both the society and individual.
Nudging	Assumes that humans are not always rational, and do not always act based solely on intention or knowledge about a particular topic. Nudging is the subtle change or environmental surroundings to push people in a certain direction.

Note. Adapted from Parajuly, K., Fitzpatrick, C., Muldoon, O., Kuehr, R. (2020).

In the case of the Rwandan plastic bag ban, the socio-economical climate can be a large driver as to why behavioural changes may not stick. Using the rational choice theory, Rwandan citizens choose to obey the bag ban to avoid fines or jail time. As a country exposed to poverty, what constitutes as rational behaviour varies according to each individual. There is compliance with the law to a certain extent until smuggling plastic bags for economic benefit to escape poverty outweighs the punishment of prosecution. Plastic bags may be the most accessible alternative to other carrier bags offered. For this reason, the Rwandan bag ban may not be as effective in inspiring lasting behavioural change.

In Quezon City, economic drivers were a good motivator to reduce plastic consumption to start. Plastic bag use has decreased with the introduction of levies, but levies were not the sole driver to consumer behaviour changes. Behavioural changes can also be influenced by community based social marketing that played into human morals. By allowing businesses to be a key player in enacting changes within their community, the responsibility to shift consumer behaviour for the hopes of a cleaner environment in the future became a collective effort on all fronts instead of a command from the top down. Quezon City incorporated numerous initiatives that encompassed the “re-use” mindset which played to the idea that

environmental change was possible if there is a combined effort between consumers, businesses, and government.

However, all behavioural changes are threatened by the intention-behaviour gap. If change is not motivated intrinsically, the influences from external environments can easily sway behaviour within the intention-behaviour gap. As consumer behaviour can be inspired through various factors that play to theories of behavioural changes (i.e. economic driven through levies, producer driven through nudging, etc.), environmental behaviour can also be reversed. Ultimately, if an individual is intrinsically motivated to make an active effort to change their lifestyle, they will be less influenced by external factors. It theorizes that an individual must pass through two different stages: motivational intention setting and volitional stage of intention striving, in order to successfully change behaviour (Bamberg, 2013). This reinforces the idea that an individual must form a strong intention and develop necessary skills and willpower to resist any temptations that may threaten the behavioural changes.

In the EU plan for a circular economy, it cites an intent to curb plastic waste and litter, as well as drive investment and innovation towards circular solutions. Investments in R&D for businesses and entrepreneurs looking to develop green alternatives were established with the aim to inspire those with creative solutions to fight against single use plastics. Both goals rely heavily on social influences present in communities. In Quezon City, although plastic bag levies were heavily enforced within the municipality, there was a large emphasis on community involvement that stemmed from business support. A key part of enacting a task force was to promote the initiative and market its benefits to citizens, encouraging business owners to provide incentives to consumers for bringing their own bags and refusing plastic. After an analysis of both strategies and the consideration of behavioural theories, the following factors need to be present in order to facilitate any change:

1. Community consensus to fight against plastic film waste litter.
2. Collaborative innovation from both community members and businesses.

2.6.2. Criteria for legislative action

Government intervention is needed to spark gradual societal lifestyle changes. Without enforcement or recommended guidelines, citizens are unlikely to rally towards a common goal or be motivated to make changes in their lifestyles once they are comfortable. To start, legislative action is the common link triggering movements and cultural shifts towards a vision of a zero single use plastic waste future.

In the EU plan for a circular economy, each focus emphasizes both government and industry cooperation. Specifically, the use of government to coerce industry cooperation whether through the implementation of stricter regulations, a governing body in industry, investment in better integration throughout value chains, etc. In addition, the use of taxation to modify single use plastic use, fines to curb litter and involvement in global affairs all require government support to be effective. Milestones and platforms enacted by the ministry to track progress are used to identify if there are any large notable changes through the years of implementation.

In Quezon City, government intervention was needed to enforce levies. Harsh fines for non-compliance were given out, as well as the threat of losing business licenses if individuals were uncooperative. Without government involvement, businesses would not be motivated to make changes in operations that incentivize the use of plastic alternatives. Businesses would not voluntarily record and monitor plastic usage without a governing body, nor would an external task force be created to monitor and track progress.

After an analysis of both strategies, it is clear the following factors need to be present to facilitate any change:

1. Established indicators to track progress, with regular reporting to a third party.
2. Enforcement of taxes, fines and levies for non-compliance.
3. Collaboration between both industry and government whether through a mutually agreed upon representative or enacted ministry.

2.6.3. Criteria for economic sustainability

As plastic is a cheap resource, their prominence in small to medium enterprises is more common as it is much more accessible than other alternatives. The \$10 billion virgin resin industry is driven by global

oil prices and continued investment into Canadian petrochemical facilities in Alberta and Ontario. With ample feedstock and the ability to manufacture plastics within the country, plastic production continues to rise. Products containing recycled plastics tend to cost more due to the lack of consistent feedstock resulting in poor quality inputs. Plastic film is a product that often gets dirty when used, and the difficult nature of processing this material (i.e. getting caught in machinery, low quality, etc.) makes it hard to find markets willing to take these inputs. With low oil prices, virgin resin manufacturers can charge less for far better quality. Key barriers found in value recovery include low diversion rates, losses from sorting and reprocessing, as well as a lack of recovery options for hard to recycle plastics (Environment and Climate Change Canada, 2019) .

Seeking to create a zero plastic waste future will require undisputed cooperation from business, industry, and the government. In the EU plan for a circular economy, there is heavy emphasis on driving investment and innovation towards circular solutions in addition to improving the plastic value chain. Instead of viewing the decrease of single use plastics use in industry as a threat to business value propositions (i.e. rising costs in transportation, storage of goods, etc.), this can be viewed as an opportunity to innovate new products or processes which in turn can create more jobs and open up new industries.

For a circular economy to be viable, the entire value chain must improve. Specifically, regarding materials used in the design of plastic products. By improving the quality of plastics recycled, it will be easier to create a market for secondary materials. Currently, the market for recycled plastics remains low due to the quality of output and logistical difficulties. By using economic instruments such as taxation, extended producer responsibility schemes, deposit systems or subsidies for green initiatives, this can give recyclers a competitive edge over virgin plastic producers. However, the discussion needs to move towards eliminating all non-essential plastic consumption to begin with. While there is emphasis can be placed on the recyclability of plastics, the reality is that plastics cannot be infinitely recycled and will ultimately end up either landfilled, incinerated or in our natural environments. There is no optimal way of dealing with plastic waste, as once it is produced it will persist in our environment in some form.

In Quezon city, plastic bags can be brought back into businesses to be recycled and sold off. This keeps litter out of waste streams and encourages a circular economy with a reuse and recycle mindset. Funds generated from recycling or levies collected are not a revenue generating scheme for the

government, and instead are directly invested in green initiatives around the city. By creating partnerships between businesses and recyclers, this improves communication along the value chain and in turn gives back in the form of an investment that funds otherwise would not be readily available for. Without these partnerships, a secondary material market would be weak or non-existent. Using levies as a method to deter single use plastic consumption not only helps to change consumer behaviour, but also gives back to the city for instances that plastic bags may be needed.

After a comparison of both strategies, the following factors need to be present to facilitate any change:

1. Investment through the entire plastic value chain (manufacturing, distribution, disposal, reprocessing)
2. Investment in R&D for plastic alternatives
3. Investment in secondary plastic markets
4. Viable and accessible alternatives to single use plastics for both consumers and businesses

2.7 Summary

The transition towards a circular economy requires multiple interventions that encompass a mix of strategies such as expanded recovery systems, reduction of waste downstream and extended producer responsibility. While waste management hierarchy prioritizes prevention first, the amount of plastic film that has already been produced still has to be addressed. In successful cases such as that of the EU, there is focus on plastics throughout the entire life cycle rather than just placing priority on prevention. From business and industry collaboration to reduce plastic usage in manufacturing, to creating more durable goods and rallying public support for sustainable consumption, the EU strategy for a circular economy emphasizes equal cooperation from all stakeholders. While Canada has embraced the idea that there are multiple considerations outside of the concept of solely prevention, the most publicly visible strategy shows otherwise (i.e. single use plastics ban) with a heavy emphasis on government intervention. There needs to be more conversation amongst the public on how to reduce plastic film usage outside of just a carrier bag ban from both consumers and industry. Plastic film is present in many commodities available for purchase and while consumers can consciously make the decision to reduce purchases including unnecessary plastic

film, manufacturers still ultimately decide how much film circulates within the economy. A strategy needs to be developed to find a place for necessary plastic film within a circular economy to minimize any detrimental environmental effects of use. A circular economy shifts the consensus from needing to purchase more, better and newer to sufficiency throughout the entire life cycle (Table 9). From producing for durability, reducing consumption of plastic for convenience and responsible waste management to prevent the amount of plastic litter in the environment.

Policy implications such as the introduction of plastic bag levies or bans have played a role in reducing the amount of film consumed, but the amount of plastic in our environment is impacted by more than just the consumption stage of the plastic life cycle. The impending federal ban on the production and distribution of single use plastics in Canada (including film) will reduce the amount of film in the environment if results follow suit to other global bag policies. However, the main issue does not lie in what strategies can help reduce the amount of single use plastics in our environment but rather what is the optimal plan in doing so and in what capacity (i.e. will this be optimal for management of all single use plastics or should certain strategies and legislation be enacted for each). There have been many interventions outlined in federal reports (Table 5) that overlap one another. However, social, economic and legislative influences must be considered throughout the entire plastic life cycle.

A circular economy is effective and sustainable. While Canada and Southwestern Ontario is aware of the implications that overconsumption and irresponsible management of plastic film brings and is open to the concept of a circular economy, there are still many missing driving factors to help accomplish this feat. Criteria established in Chapter 2 through successful case studies and academic literature helped to identify the measurable steps needed to move Canada towards circularity. To further fill in the knowledge gaps, Chapter 3 will delve deeper into how successful the application of current interventions determined by the Canadian government may be. By narrowing the focus to solely plastic film within a geographic area and getting input from industry experts, in addition to using these interventions as a guide, we can identify where the barriers to implementation may lie. Combining knowledge gathered from both sections can help forge a clear path ahead towards circularity.

Chapter 3 – Methodology

A circular economy requires consideration from both sides of supply and demand within our linear economy, and production and consumption must evolve to enact transformation (Sijtsema et al., 2020). However, with continued investment into the petrochemical industry driving down the cost of plastic, the perceived value of both plastic film as a commodity in business and impact to the environment is low. Community systems (such as how a citizen may view waste management or plastic) can be influenced by social and legislative drivers, but market influences ultimately determine what becomes feasible. Plastic waste is largely an economic issue (Aldag, 2019).

After an initial review of key criteria that needs to be met throughout the entire life cycle of plastic film established in Chapter 2, it is clear that the dominance of linearity in business models within Canada presents itself to be a barrier towards the transition towards circularity. However, what inhibits circularity within Canada and Southwestern Ontario specifically is still unclear from the initial literature analysis. Further information as to what political, social and economic factors play a role in sustaining linear business models are required from industry stakeholders and key players in plastic waste management to determine feasible solutions moving forward. This section will detail methodology (interviews and documentation) used to uncover what barriers currently exist in a Canadian and Southwestern Ontario landscape, and why each method is appropriate given the context and nature of data collection.

3.1 Research Design

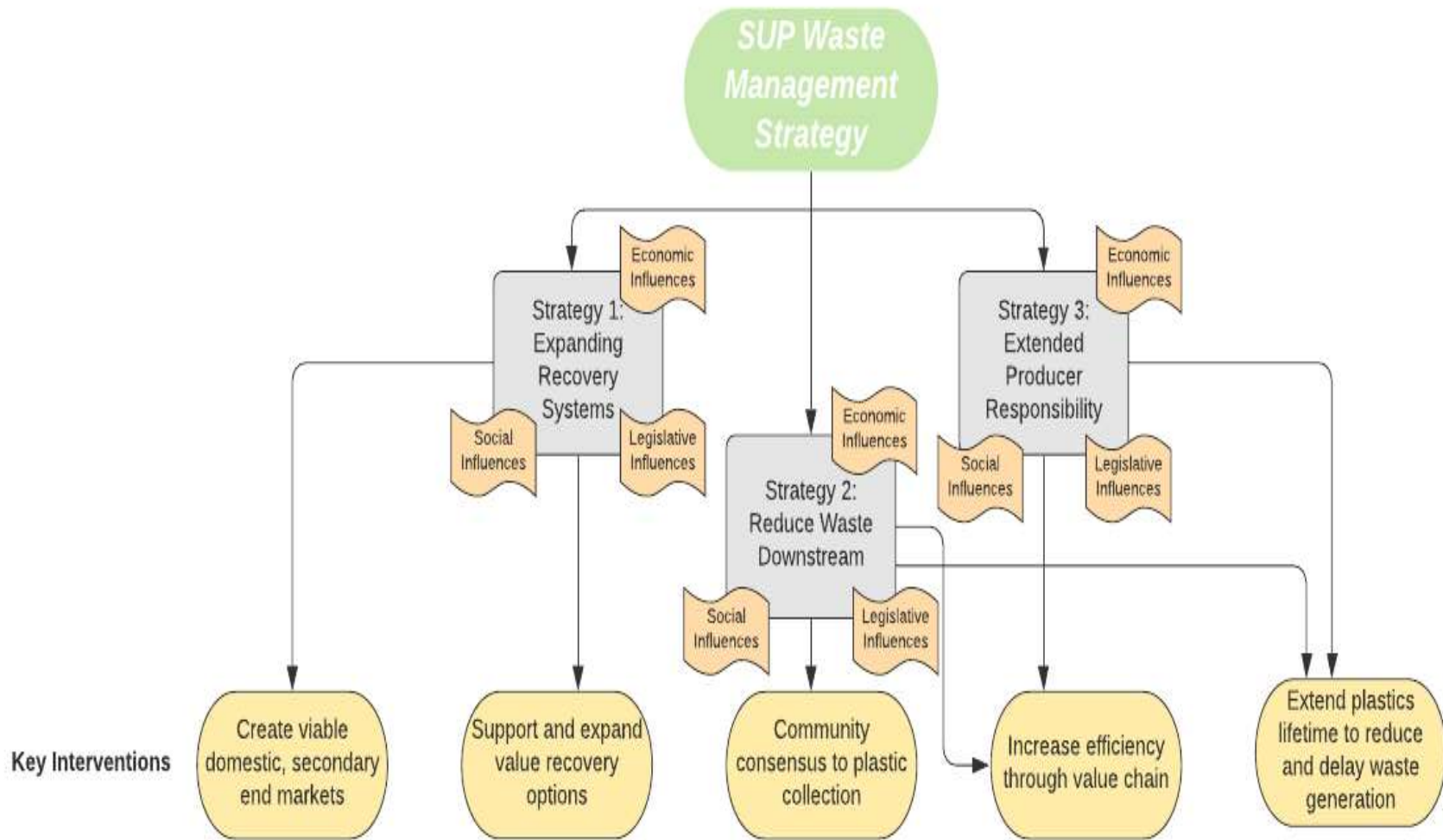
The introduction of a circular economy as a means to manage plastic film waste proves to be a valuable concept as outlined both in literature and real-life applications (such as the case of the EU). Common criteria found amongst successful applications for circularity as highlighted in Chapter 2 reinforce the idea that the best chance of managing the plastic crisis requires a multi disciplinary approach. There have been various circular strategies presented both in academic literature (Stahel, 2016; Esmailian et al., 2018; Geissdoerfer et al., 2017; Nielsen et al., 2019) and in government such as in the Canada-wide Action plan on zero plastic waste (2018), Phase 1 (2019) and 2 (2020). However, it remains that there is

no unified response to tackling the plastic crisis. This makes it difficult to create a road map with appropriate interventions that transitions Canada towards a circular economy.

While proposed interventions from the Environment and Climate Change Canada report (i.e. *creating viable domestic and secondary markets, community consensus to plastic film consumption, support and expand recovery systems, increased efficiency throughout the value chain and extended plastics lifetime*) in some way adheres to popular strategies found in practice and literature (i.e. *reduction of waste downstream, expanding recovery systems, extended producer responsibility*), the efficacy of each strategy relies on a variety of social, legislative and economic factors. As such, each question developed for data collection specifically needs to relate to a unique intervention and influence to organize direct correlations between strategies and influences that can help or harm the impact of each proposed intervention (Figure 2).

Although Canadians as a whole share similar values, everyone is swayed by the community that surrounds them. In theory, strategies that can be effective in a Canadian society can impact certain provinces, regions or cities differently. By designing this study to collect opinions from industry experts, businesses and consumers, we can predict the reception of each strategy given the current socio-economic climate, as well as any challenges that may surface along the way. As Southwestern Ontario is a heavily populated area in comparison to other regions in Canada, selecting this area is a starting point. Qualitative research methodology is required to conduct a successful analysis on plastic film and packaging waste strategy, as it allows for a greater understanding of key influences in the industry and any barriers there may be to implementation. Although there are tentative laws in place with the aim to reduce plastic waste and encourage a circular economy, ultimately in order to reduce plastic waste, collaboration is needed amongst consumers, industry and government to consume less and improve waste management habits.

Figure 2: Single Use Plastic Waste Management Strategy



This thesis will adopt a similar outline to current Canadian plastic waste management strategies put forth by the government, with first-hand knowledge inputs from industry professionals. Qualitative methodology was chosen as the focus for data collection because an analysis of current strategies presented needed to be completed. Qualitative data places an emphasis on qualities of entities, as well as processes and meanings that are not normally able to be experimentally measured quantitatively with amounts, intensity or frequency (Denzin & Lincoln, 2011). In this case, collecting quantitative data from public waste records, or recycling statistics would be complementary to first getting professional opinions on the plastic film and packaging waste industry as a whole. Research design and analysis using qualitative methods do not have a “one-size-fits-all” approach, but rather draws from diverse structures. The purpose of qualitative methodology is to educate readers on the intent and purpose of the study, analyze information through multiple steps, discuss approaches to validate the research and accuracy, as well as pull from a large collection of data sources (Patton, 2015). All of which are applicable to this study.

While qualitative methods can provide a more detailed breakdown of the complexity behind plastic film and waste management, data was more difficult to analyse into categories due to the wide range of answers that were collected.

There were three different kinds of qualitative data collection methods initially considered: interviews, observations and fieldwork, and documents (Patton, 2015), with multiple factors considered prior to the selection of methodology (Table 9). Ultimately, interviews were determined to an effective source of data collection. Interviews conducted focused on open ended questions that yielded in depth responses about personal experiences, perceptions, opinions, feelings and knowledge. Data collected consisted of verbal discussions between the researcher and subject whereas documents focused on written materials and documents from organizational records.

Table 9: Summary of Research Considerations

Purpose	To add additional context to plastic packaging and film waste management in Southwestern Ontario by identifying sustainable and effective circular strategies
Primary Audience	Government, administrators, city staff members, etc.
Questions that will guide the Inquiry	Practical, applied and action-oriented to yield concrete answers about plastic film and packaging waste management.
Data Needed	Rich and meaningful data that seeks to identify changemakers and what influences decisions in each area (to come from qualitative methods: interviews/documents)
Resources Available	Online access to previously proposed strategies, access to directory of contacts (publicly available on municipal websites), public records on recycling rates and waste consumption, 1.5 years to complete the study including data collection
Criteria for Analysis	Evaluation standards (utility, feasibility, propriety and accuracy)

The purpose of my research was to add additional context to plastic film and packaging waste management knowledge in Southwestern Ontario by identifying sustainable and effective circular strategies. Although the technology in question here would be the Canadian waste management and recycling industry, insights derived from the study will shed light on the criteria needed to be met in order to transition towards a circular economy. The transition towards a circular economy relies heavily on government intervention such as policy changes restricting unnecessary plastic film production and use, as well as from entering the waste stream given the potentially damaging environmental implications that citizens are currently worried about.

The Canadian government has announced its intention to ban single use plastics, however, this process will likely be lengthy with multiple exemptions, and Canadians will have to figure out how to manage the plastic waste produced already as well as adapt to the new normal. Plastic film and packaging are found everywhere in society whether it be in stores or restaurants in the form of plastic bags, takeout boxes, etc. or in our homes in food packaging or pharmaceutical packaging. Given the resources available, *i.e. time, limited access to contacts*, as well as what data is needed, *i.e. meaningful data from changemakers through documents*, personal discussion was needed to add depth to statements and give context to influencing factors that can drive change in this area of research. Early parts of the interview were designed to help the subject develop their own narrative to give the interview direction and depth. Questions were open-ended to allow for this but will still be focused and carefully tied into the research topic. The objective of the interview was to guide the participant in sharing their experiences and context of the situation as it relates to the topic of interest (Galletta, 2013).

As plastic film and packaging waste management is presently a global issue that has garnered the attention of the Canadian government (i.e. push for single use plastics ban, Chinese import waste ban, etc.), it is a topic with policy implications. The primary audience that this research targets is government, administrators, city staff members, etc. For this reason, interview questions focus on the practicality of strategies presented currently by the Canadian government. The semi-structured nature of the interview is designed with considerations that those in industry will have a broader understanding of what is feasible in current landscapes, tying both into their experiences in industry and as a consumer. Data collected looked to identify changemakers and what influences decisions in each area. Current resources available are online access to previously proposed strategies, publicly available contact information and records on recycling rates or waste consumption.

However, due to COVID-19 pandemic restrictions there were a limited number of participants in the study and there was a large focus on remote interviewing through methods such as video call, telephone and email. In total, six in-depth interviews across all stakeholders were collected with the gaps in knowledge filled using secondary research from literature.

3.1.1 Question Framework

The interventions addressed in the Environment and Climate Change Canada (2019) report; *creating viable domestic and secondary markets, community consensus to plastic film consumption, support and expand recovery systems, increased efficiency throughout the value chain* and *extended plastics lifetime* are largely economically influenced. These interventions are specify actions to be taken to move towards progress, serving as valuable reference points during data collection.

Table 10: Correlation between Interventions and Popular Waste Management Strategies

Strategy Overview and Description
Reduction of Waste Downstream
<p>These interventions will require cooperation from public, industry and government players in addition to advanced recycling technologies (Hopewell, Dvorak, & Kosior, 2009).</p> <p>Direct Intervention related to: community consensus to plastic film consumption, increased efficiency throughout the value chain, extended plastics lifetime</p>
Expanding Recovery Systems
<p>To support expanded recovery systems, creating economic incentives for commercial sectors and materials recovery facilities can create an additional presence of these players within Canada. If more materials recovery facilities are capable of recycling plastic film, this creates additional outlets for people to divert their plastic film waste from landfills. Ultimately, this may encourage a societal shift that increases diversion rates.</p> <p>Direct Intervention related to: creating viable domestic and secondary markets, support and expand recovery systems</p>
Extended Producer Responsibility
<p>By creating standard requirements for extended producer responsibility, it enables producers to reassess their plastics usage to determine whether certain uses are justifiable under legislation (Environment and Climate Change Canada, 2019). The end goal would be to eliminate plastic film usage in totality or reduce the need to integrate film into products. This would require additional support from governments to create appropriate waste reduction targets and ensure compliance to these standards. However, creating realistic transitional periods to attain this goal will require both consultation from local governments as well as participation from commercial sectors.</p> <p>Direct Intervention related to: increased efficiency throughout the value chain, extended plastics lifetime.</p>

In addition, these interventions in some way adhere to popular recommendations found throughout literature: reduction of plastic production and waste downstream (Jambeck, et al., 2015; Hopewell, Dvorak, & Kosior, 2009), expanding recovery systems (Jambeck, et al. 2015) and introducing extended producer responsibilities (Lindhqvist, 2000) as summarized in Table 10. Each question developed for data collection is correlated to a specific intervention and is designed to determine the feasibility of each.

3.1.2. Participant Selection

Major stakeholders consulted in similar studies span across both public and private sectors. Data sets for this thesis are collected from similar stakeholders such as waste management professionals, environmental groups, etc. in addition to literature. These groups will be included in the key informants to approach because they are knowledgeable about the topic in some way, important sources for this specialized issue, able to provide future direction, and will be able to show diverse representation that is able to be combined with alternate sources to provide some sort of rich context to the issue at hand (Patton, 2015). However, those stakeholders that were unable to be contacted were substituted with additional secondary research (Table 11).

Table 11: Stakeholder Overview

Stakeholder	Geographic Region	Reason for Contacting	Substitution – if unavailable or additional data needed
Business-Ontario Cannabis Stores	Ontario	A large amount of plastic packaging is used within the pharmaceutical industry to protect medicinal goods, as well as to prevent tampering. Changes in plastic waste management legislation will have a large impact on business as usual.	None
Business-Food packaging	Nation wide	A large amount of plastic packaging is used within the food processing industry to protect and prolong goods, in addition to preparation for transportation. Changes in plastic waste management legislation will have a large impact on business as usual.	None

Landfills	Western/ Southwestern Ontario	Plastic film and packaging waste take up valuable space in landfills when not properly recycled, and often contribute to litter in surrounding areas as single use plastics are often light and tend to blow. Change in legislation regulating single use plastics will prolong the life of landfills and have an impact in current operations.	Publicly Available Documents
Landfills	British Columbia	Single use plastic film and packaging are banned in certain municipalities, and there is a large movement towards a low waste future in BC. Current impact to society as well as waste management in the province can help gauge the future of Ontario plastic waste management.	Publicly Available Documents
Processing Plants/MRF	South Ontario	Both processing plants and materials recovery facilities play a key role in introducing recycled plastics back to society, as well as contribute to the success of a secondary market for plastics. Changes in legislation regulating single use plastics will have an impact in business as usual by regulating their inputs/outputs.	None
Organizational Groups	Nationwide	Organizational groups play a key role in pushing forward changes within their industry. They represent common interests across the businesses or individuals that they represent. Certain groups with interests in food security, plastic production, etc. will be impacted by changes in legislation regulating within their industry.	None
Industry Professionals-Environmental Consulting	Southwestern Ontario	Experience in environmental consulting for the government or for businesses can help determine what barriers to implementation may be when it comes to determining an appropriate strategy moving forward with a focus on low to zero single use plastic waste in Canadian society.	None

Due to the complexity of the issue and the multidisciplinary nature behind policy making, influences that drive change may pull from all directions. **Mixed, stratified and nested sampling strategy** was used for data collection. Starting with **group characteristics sampling** using key informants and quota sampling, credible sources were identified with diverse insights to build off. Some stakeholder groups redirected certain questions and inputs to alternative groups for deeper insight. In this case, snowball or chain sampling were utilized to build off my initial contact base to find other relevant contacts. Each stakeholder or changemaker has a direct impact on either (a) the amount of plastic film and packaging waste produced, and/or (b) what happens at the end-of-life cycle (i.e. landfilled or recycled into secondary

markets). By establishing the impact of each influence, we can identify any barriers to implementation, or the feasibility of any waste management strategy put forward. For unattainable first-hand data from a sample group, documents were used as a substitution in the form of publicly available records or reports published. However, further documentation such as public city records or reports were analyzed to fill in any gaps in knowledge during secondary data collection where the focus lies primarily in identifying effective strategies within a Southwestern Ontario landscape.

3.2 Data Interpretation

The following questions were used as a guide to develop appropriate qualitative methodology and semi-structured interviews:

1. Legislatively; how does Canadian packaging and film management standards impact the amount of film used in everyday products which will ultimately end up collecting in our landfills?
2. Socially; how will societal norms and habits influence the overall effectiveness of a plastic film waste management strategy in Canada and/or Southwestern Ontario?
3. Economically; how will businesses in Canada/Southwestern Ontario be impacted financially through the implementation of stricter plastic film management standards?

Data was recorded using the following items: factor, data set(s), impact and code (Table 12). Data collected is coded according to relevant interventions as listed above (1-5), as well as influences (S- Social, E-Economic, L-Legislative, EK- Extended Knowledge).

Table 12: Data Collection Record

Questions Asked	Questions asked during the interview process
Stakeholder Group	Stakeholder groups represented
Responses	Inputs from stakeholder group
Code	Relevant interventions/Influence

3.3 Secondary Data Research Design

To fill in the gaps in knowledge from lack of knowledge from primary data collection regarding businesses and materials recovery facilities (including processing plants), the following documents were reviewed respectively for each stakeholder group: State of Waste Management in Canada (2014) and The Last Straw: Turning the Tide on Plastic Pollution in Canada (2019). These documents were chosen due to

the in-depth knowledge that they provided on both commercial and government viewpoints regarding plastic waste management. The private nature of commercial businesses is a barrier for data collection as businesses can choose whether to share information regarding their operations. However, the report *State of Waste Management in Canada (2014)* provides a detailed analysis on the commercial nature of plastic waste collection and management. It includes valuable information on national plastic waste policies, including government initiatives that encourage responsible waste management. Additionally, the report *The Last Straw: Turning the Tide on Plastic Pollution in Canada (2019)* provides key targets, government insights and standings on plastic waste pollution within Canada. Since material recovery facilities work closely with governments, guidelines regarding how to manage plastic waste markets will vastly impact the efficacy of circular strategies. This report also provides key insights regarding how waste management within Canada works, and will also serve as a reference for any gaps in knowledge from landfill operations.

For landfill operations and waste management industry experts that were unable to participate in the initial set of interviews, public records for waste composition were studied to fill in the gap in knowledge regarding specific program initiatives and quantitative data such as the makeup of single use plastics in landfills (Table 13). Any initiatives that looked to divert single use plastics from the waste stream that are being implemented or plan to be are noted as well. By identifying the single use plastic waste makeup of Southwestern Ontario landfills, we can determine what impact single use plastic waste has on the lifespan and operation of each, in addition to establishing similarities between successful diversion strategies that can be implemented regionally. Reports and websites selected from each respective municipality aim to provide knowledge that otherwise would have been accessible through a municipal representative.

Table 13: Reports Analysed for Secondary Data Collection

Stakeholder Group Represented	Reports/Website Analysed
Materials Recovery Facilities (including processing plants)	The Last Straw: Turning the Tide on Plastic Pollution in Canada (2019)
Businesses (including organizations)	State of Waste Management in Canada (2014)
Landfills (including waste management industry professionals)	A Waste Recycling Strategy for the City of London (2014)
	City of Hamilton Solid Waste Management Master Plan Review (2012)
	Essex Windsor Solid Waste Authority 2011 Solid Waste Management Master Plan Review and Update (2011)
	Essex-Windsor Residential Waste Diversion 2018 (2019)

	Waste Strategy Programs & Initiatives (2020)
	Blue Box Ins and Outs Niagara Region (2013)
	2015/2016 Seasonal Low-Density Residential Dwelling Curbside Waste Composition Study (2016)
	Waste Reduction and Diversion Study (2013)
	Regional Municipality of Waterloo, Process/Equipment Review, Material Recycling Centre (MRC) (2017)
	The Last Straw: Turning the Tide on Plastic Pollution in Canada (2019)

3.4 Research Ethics

Ethics clearance was received from the University of Waterloo’s Office of Research Ethics on February 11th 2020 under ORE#41689 and the title Plastic Packaging and Film Waste Management in SWO.

Chapter 4 - The Circularity of Plastic Film within Canada (Analysis/Results)

4.1. Primary Data Collection

This chapter will present results from information gathered in interviews as outlined in Chapter 3. Data is collected and organized into 3 key stakeholders' groups: materials Recovery Facilities (including processing plants), landfill operations (including waste management industry experts) and businesses (including organizations). Interviews were first used as a primary source of data collection, with gaps in knowledge then identified and filled in using secondary data collection from publicly available documents. Ultimately, this section will provide insight to answer the research question: **“What are the challenges and opportunities associated with plastic packaging and film waste management?”** from a Southwestern Ontario viewpoint. This is achieved by conducting **a detailed analysis on the practicality and feasibility of each intervention presented in the Environment and Climate Change Canada (2019) report on plastic waste and markets.** Using data collected from both the public and commercial sectors, we can identify what barriers currently hinder progress towards circularity.

4.1.1. Materials Recovery Facilities (including processing plants)

Materials from materials recovery facilities will come directly from the blue box program set out by a municipality. These plants are responsible for collecting, sorting, and preparing recyclables for end markets and essentially act as a middleman between the consumer (who throws out the plastic) and the processing plants (who receive the sorted plastic and prepare it for sale in secondary markets, i.e. pelletizing the received materials). Each materials recovery facility has different processing capabilities, although the more common materials processed are: PET (#1), HDPE (#2), and mixed plastics (#3-7). It is uncommon for plastic film to be accepted in blue bins as film is a costly material to process with low return on investment. Materials recovery facilities are extremely labour intensive as a huge portion of the operation is collecting blue bins, as well as manual sorting if needed. Since materials recovery facilities and processing plants play a crucial role in reintroducing plastic waste as secondary products back into the market, they are grouped together in the same data set as both groups have similar impacts to the industry in question (Table 14).

Table 14: Materials Recovery Facilities (Factors/Data Sets)

Questions Asked	Stakeholder Group	Responses	Code
Lack of film processing/Barriers to recycling film	Processing plants	Film is generally polyethylene or polypropylene. Cross contamination occurs when introducing different types of polymers in the plant. Different equipment is needed for different polymers, so there are rules and processes in place where you don't or mitigate the risk of cross contamination. Mainly for logistical and economical reasoning.	1EC,3EC
Main markets served/Import regulations	Processing Plants	Automotive, medical and construction industries are served. Most markets are for more "durable" plastics. Chinese import regulations have not affected operations.	1EC
Technologies needed to process low value plastics (i.e. film)	Processing plants	More infrastructure, logistics and equipment needed. Automation within the industry will be important, and the need for recycling these materials will be higher.	3EC, 4EC
	Materials Recovery Facilities	New technologies need to be incorporated within the processing: film grabbers, manual to air suction, optical sortation, etc. Impact in efficiency is heavily outweighed by the loss in production (capital cost vs cross contamination vs revenue generated), that make film plastic a feasible product to capture	
Economic/Social drivers needed to include plastic film processing within the industry- factors needed for national and global markets	Processing Plants	<p>Look to protect the planet and the environment, assisting people with processes and materials that will help them become successful. Ultimately make money and create jobs. Need to define the term "single use plastics" better, as it is not consistent (i.e. banning straws but not lids).</p> <p>Film is a cheap resource that looks good in manufacturing, with low processing costs in comparison to other materials. Companies are always trying to get away with cheaper materials, while being able to still have their product look good. Film looks bad in the media but has many useful purposes. Film is not the issue; people need to be better educated on the usefulness of it and how to manage it.</p>	1EC, 1S

	Materials Recovery Facilities	<p>Municipalities will determine whether or not to exclude plastic film. If extended producer responsibility is introduced, producers will need to be responsible for the material.</p> <p>Companies that produce film will have better insight on the largest drivers in the market.</p> <p>Economic drivers: will come down to cost vs revenue vs environmentally correct. What are cities and eventually producers willing to spend to capture and market film? Adding film to the recycling stream impacts all aspects of operations.</p>	
Presence of market for secondary film materials over the next 5/10/15 years	Processing Plant	<p>Market will increase over the next 5 to 15 years as consumerism rises. Big box stores will produce more and will need packaging. Often, packaging costs are higher than the cost of the product itself. Consumers will have to recycle more, and businesses will need to find a way to reduce packaging costs. This can be done by introducing recycled materials back into packaging.</p> <p>Recycled materials can be cheaper than virgin materials depending on the volume and end use, as well as facilities available in each processing center.</p>	3EC, 3S
	Materials Recovery Facilities	<p>A market will have to exist as the amount of plastic film produced is increasing. With extended producer responsibility coming, this can be better answered by producers.</p>	
Advancements needed in processing technologies to allow more MRFs to take in plastic film	Processing Plants	<p>Entertained the idea of being the logistics arm to pick up materials, but it's a whole new logistical cost and economic endeavor that needs to be investigated further. The biggest cost in recycling is the logistics. Improvements would need to be made logistically in order to reduce the price to make recycling certain materials more competitive in comparison to virgin materials.</p> <p>Would collect film if the technology is more accessible. Currently piloting a project to collect blood bags and recycle them, however, we are only doing this because it is a subsidized program. There needs to be incentives for manufacturing companies to recycle products and avoid carbon.</p>	3EC,3S

	MRF	This is decided by the municipality. Funding is a factor in making technologies more accessible.	
Factors for successful plastic management	Processing Plants	Having good processes and relationships with manufacturing companies that need these materials. Controlling internal costs to support that and having a crew that understands what needs to be done in order for plastics to be processed well. Infrastructure and support from the government to provide incentives to keep processing secondary materials competitive is important. Cost and quality are two main factors.	2S
	Materials Recovery Facilities	Packaging standards. No rules exist in the plastic packaging industry currently.	
Influence and contribution of MRFS to creating a circular economy	Processing Plants	Contribute more to the cradle to grave approach. Logistics within facilities need to be improved, creating an education portion to sorting materials can be beneficial as not all plastics are made the same and a lot of money can be lost on just sorting or cross contamination. Canada does fairly well with industrial recycling, but a lot of room for improvement on the residential end. Europe is far more advanced in this.	3S
	Materials Recovery Facilities	Materials recovery facilities can contribute as long as residents can follow guidelines in community recycling. Without materials recovery facilities, there can be no circular economy and the public would need to rely on public drop off depots for each material type, adding several steps in the cycle and increasing costs.	

4.1.2. Landfill Operations (including waste management industry experts)

Landfills will bear the brunt of an increasingly prominent plastic environment. Recyclable materials collected all depend on contracts that are being held currently. However, most plastics will end up landfilled rather than recycled as it is much cheaper to dispose of the material rather than to divert it and in turn, take up valuable landfill space. Roughly 2-4% of waste generated in Southwestern Ontario will be residential plastic film, although this number will vary from municipality to municipality.

Plastic film is prevalent across every industry and production will likely continue to grow because businesses are constantly trying to find ways to make things lighter without affecting functionality. There is a lack of consistent data on plastic film production or use, as more studies will generally focus on single use plastics in an all-encompassing manner (i.e. bags, packaging, containers, etc.). Considerations from landfills located within municipalities with and without plastic bag bans, in addition to waste management industry experts in environmental consulting are included within this data set to see if there are any fundamental differences in the idea of what can propel a successful single use plastics waste management plan (Table 15).

Table 15: Landfills w/ and w/out bag bans (Factors/Data Sets)

Questions Asked	Stakeholder Group	Responses	Code
Capacity of plastic products within landfills and effect on operations	Landfills (w/out ban)	<p>Estimated at 15-20% residential, most of the waste comes from industrial or commercial sources. A compactor works to push the waste down, but since the increase in plastics in landfills, the compactor does sink. Most landfills were made up of heavier items before, but now that most of the landfill is plastic, it causes logistical issues that were not present in the past.</p> <p>Landfill life is not prolonged because plastics still take up the same volume. Environmental issues are relatively still unknown.</p>	EK, 3EC, 3S, 4EC, 4S
	Landfills (w/ ban)	<p>Plastic products are about 14.3% of waste intake. Between 2010 to 2016, plastic in waste composition increased 1.8% but there was a 3kg/capita drop between 2010 to 2016. This is likely due to improvements in recycling programs.</p>	
Chinese import ban on plastics	Landfills (w/out ban)	<p>Markets are low with Chinese markets closing off. There is low demand for plastic film, municipalities located further away from dense populations (i.e. GTA) will find it harder to recycle as most recyclers will locate themselves closer to cities rather than rural areas. A lot of film will end up in landfills.</p>	2S, 3EC, 3L, 4EC, 4L
	Landfills (w/ ban)	<p>Lack of markets for materials and limited collection infrastructure led to more plastic film prevalence in landfills.</p>	
	Industry Expert	<p>Not sure if there is a huge impact, the issues lie mainly in the fact that there is more of a focus on how much is</p>	

		collected rather than quality. How much low quality items get recycled is a good question.	
Short Term/Long term Effects of plastic film and packaging in landfills	Landfills (w/out ban)	<p>Short term: logistically, there are more issues. Now there is more litter. Since it is light, it blows, and we have to make sure that it is not ending up in a neighboring farm or property.</p> <p>ST to LT, every landfill has to carefully monitor that it will not pollute our environment. Long term, we have to look at the effects on our groundwater to make sure our leachate won't contaminate it, and our gas generation. This will be decades in the making, but how much is plastic film is probably a miniscule amount in comparison to everything else.</p>	2S, 3EC, 3L, 4EC, 4L
	Landfills (w/ ban)	<p>Plastics comprise of approx. 15% of waste received.</p> <p>ST: plastic can be picked up by birds (eagles and seagulls are prevalent), and they can potentially carry the plastic off site or ingest it.</p> <p>LT: plastic bags in particular can take 10-1000 years to break down under anaerobic conditions, no chemical quantification to determine the impact of plastic breaking down in the landfill. Leachate, ground water, surface water samples for a suite of parameters such as metals, anions, leachate indicators, etc.</p>	
	Industry Expert	<p>Film is not a huge part of landfill capacity, it's just more of a hard material to manage because it blows (leaking into the environment).</p> <p>The public can help control the leaking (i.e. milk bags, plastic can fall down drains). We can be more careful.</p>	
	Landfills (w/out ban)	<p>Many municipalities will have anti-littering and clean up campaigns.</p> <p>Public initiatives on a municipal level talk a lot about litter, not so much on waste diversion. Waste diversion campaigns on reducing food waste is definitely growing nationally (i.e. love food, hate waste), most provinces will have a chapter. In terms of plastic, the campaigns will have to do with Great Lakes or local waterways/the oceans and reducing the amount of plastic that goes in (i.e. great shore clean up). We need to look at more litter prevention.</p>	2S, 2EC, 2L
	Landfills (w/ ban)	<p>Promote the 5R hierarchy, reduce, reuse, recycle. Opportunities are limited to municipal programs for residents and a few businesses taking commercial film.</p>	

<p>Initiatives (current/future) that can encourage waste diversion</p>	<p>Industry Expert</p>	<p>Some capture marine plastics, or agriculture (i.e. using drop boxes).</p> <p>Extended producer responsibility/stewardship programs in place, some voluntary programs (i.e. return to retail). There was a large effort with return to retail, and we were able to move forward with reducing plastic film usage (i.e. plastic bag ban was a voluntary agreement signed between industry, retailers and government over a period of time)</p>	
<p>Barriers to waste diversion/ ways they can be overcome</p>	<p>Landfills (w/out ban)</p>	<p>Film is ubiquitous.</p> <p>Wishful recycling: people will put it in the blue bin thinking everything gets recycled, this encourages consumerism. Single use plastics would be convenient, most people that get fast food will not be conscientious enough to bring their own Tupperware.</p> <p>To overcome this for a zero waste future is doubtful, on a smaller scale it is definitely possible. A lot of places are doing better than Canada, we generate the most waste per capita. There is no real indication that a zero waste future has happened or is happening.</p> <p>You'd be looking at two different subsets of people, litter created by people that don't care. Convenience trumps it all out.</p>	<p>2S, 4S</p>
	<p>Landfills (w/ ban)</p>	<p>Knowledge about waste generation (reduce/reuse) and collection infrastructure (recycle).</p>	
	<p>Industry Expert</p>	<p>Largest barrier: cheap to produce virgin plastic, and very expensive to properly manage and collect the material/utilize it into a new product.</p> <p>Government would be the greatest help here (i.e. making recycled content a requirement). Initiatives such as extended producer responsibility, mandatory content requirements/forms of taxation will be what levels the playing field between virgin/recycled commodities. Economic influences are huge drivers.</p> <p>Confusion between what can actually be recycled also causes issues (efforts by consumers will help create an effective/efficient market), but not knowing what is compostable, biodegradable, etc. and how they can be better properly managed by the public. Industry does a poor job standardizing and there is a lack of government enforcement.</p>	
<p>Influences within municipalities to</p>	<p>Landfills (w/out ban)</p>	<p>Social influences must be present. There have been cases of landfills being developed to store trash from other municipalities, with flack coming from residents</p>	

<p>encourage waste diversion</p> <p>(Possibility of diverting all film from landfills over 5/10/15 yrs?)</p>		<p>that do not want outside trash coming in. There will be a big push for a zero waste movement and waste reduction efforts if this is the case.</p> <p>It is not possible to have zero waste, but possible to make a dent in it. Soft plastic can be recycled, but crunchier plastic film (blended with different plastics) is harder/more expensive to recycle. You have to separate the different plastics in order for it to be used in the industry, and that's more expensive. Doubtful that oil will become that expensive that you would need to recycle plastic film.</p> <p>Not sure if there will ever be markets to push for film not to be thrown out or recycled 15+ years. In order to encourage waste diversion, a mix of all of those factors will need to be at play.</p>	<p>1EC, 2S, 5S</p>
	<p>Landfills (w/ ban)</p>	<p>Legislative influences are important. Landfill bans are put in place where diversion programs exist.</p> <p>Not possible over 5-15 years, but increased diversion would be possible through expanded local markets for material.</p>	
	<p>Industry Expert</p>	<p>Landfill capacity is a huge influence. Lack of capacity will lead municipalities to adjust their policies. Not only waste diversion will help, but waste reduction overall. Will start to see municipalities saying businesses should only provide bags if asked, etc. Businesses can provide incentives to using reusable (i.e. discounts/charges). You can see more of this with plastic bags. Possible to divert with technological advancements.</p> <p>Advances in chemical recycling allows us to process products that can be contaminated- policy tools will help encourage better understanding and implementation. Not within 5 years time, maybe 10.</p>	
<p>Influence of any landfill in the creation of a circular economy</p>	<p>Landfills (w/out ban)</p>	<p>Harder to do in larger municipalities, easier to do with smaller ones (out of sight/out of mind). People will drop their trash off curbside and forget about it, where in a small town you might have to bring it to the landfill yourself.</p> <p>We can always manage better in this department and governments that overlook this can do a better job at making people realize the impacts of the landfill and how much they are throwing out versus the importance of the recycling system/reuse programs.</p>	<p>2S, 5S</p>
	<p>Landfills (w/ ban)</p>	<p>Landfill activity can play a role in supporting a circular economy through landfill bans/financial disincentives.</p>	

		Landfills cannot create a market for recyclable materials or develop collection infrastructure.	
	Industry Expert	<p>Landfills are cheap. (i.e. Michigan disposes at under \$10/tonne). Landfill/disposal tax is focused on increasing diversion. Landfills and how they price have an impact (they are important because waste you can't properly manage is appropriately disposed of).</p> <p>Landfills could be an important hub for waste diversion -but they are not the main drivers to a circular economy. Newer landfills right now are centered around diversion (i.e. they will have paper facilities on site, etc.).</p>	
Optimal plastic film waste management strategy (Where is the focus)	Landfills (w/out ban)	<p>No future production will never happen. It's a useful material (food production, medical) to keep everything safe. Optimal strategy would be not to produce it in the first place, but main focus should be on reduction and how much is generated in non-essential areas (i.e. grocery bags). That's an area we can all have an effect in (residential sources).</p> <p>Industrial generation definitely contributes more (i.e. shipping), the strategy for this would have to target industry with less film generated.</p>	EK
	Landfills (w/ ban)	Plastic Action plan (good guiding document) that outlines steps to reduce plastic use.	
	Industry Expert	<p>There is a use for plastic film, but there needs to be better management of it. We should find systems that require organizations to be responsible. We need to figure out the right collection systems to properly capture materials (i.e. blue box, return to retailer, etc.) Is there a mixed way of processing that is necessary to pull as much of this stuff out of the waste stream into chemical recycling (cleaning it up)?</p> <p>Optimal strategy will be driven by policies (i.e. extended producer responsibility). We need better data to make sure that the system is enforceable (right now there is no accountability). We need driven end markets that make it advantageous to capture material and reuse it back into products. Better collection infrastructure will be driven by elements such as better pricing for end materials and making producers responsible for those products.</p>	

4.1.3. Businesses (including organizations)

Since commercial and industrial waste make up most of the plastic in our waste stream, businesses are key drivers in the fight for a low to zero plastic waste future. As society evolves, businesses are constantly looking for ways to innovate packaging to improve product effectiveness or solve transportation challenges. With the announcement of a single use plastics ban in Canada, there has already been a federal announcement stating that the ban cannot move forward without the cooperation of businesses. Accessible alternatives need to be considered prior to moving forward with any changes in legislation. However, due to the private nature of most businesses, both lack of cooperation and publicly available data from commercialized industries, direct input from industry was not included. Instead, agricultural waste management organizations were elaborated on in this section due to their involvement within private agricultural and food packaging industries (Table 16).

Table 16: Agriculture Waste Management Organizations (Factors/Data Sets)

Questions Asked	Responses
Presence of plastic film waste management strategies in Western Canada vs Ontario	<p>Most prevalent is the grain bag recycling in Saskatchewan. This is a completely different kind of product. This is mainly used in Western Canada (not sure if Ontario has the same kind). There are currently recycling markets for the product because it's used in sufficient volumes that you can get economies of scale. There are also government regulations that have put onus on the industry to develop a recycling program.</p> <p>There are pilots for bale wrap programs in Manitoba, but they are in more of a pilot phase and that is why they exist in Manitoba (government funding). No government funding is available in Ontario, and that is often one of the ways that a recycling program gets started.</p> <p>It helps when you transition a program from a government run to industry run because the basic research is done already and it's common to see that sort of start on government resources</p> <p>Farmers no matter where they are located will have a strong commitment to the environment (they will need it for harvests year after year). In Ontario, the focus has mainly been on household packaging, so by nature that would exclude anything in the agriculture field. Also keep in mind the impact of agriculture on the economy out west versus Eastern Canada.</p>
Economic influences on consumers (farmers)	Consumers/farmers do not like added fees. In farming, when cost effective recycling programs are available, they will use them. Farmers would be receptive to a program at a reasonable cost that they can see a benefit from.

Take back programs	<p>Some take back programs may/may not exist. A collection service may be offered but not necessarily a recycling program. Numbers in plastic film are hard to gather.</p> <p>The markets are in a tough spot right now, with China closing their doors to recycling. This really impacted our organization because we were in the process of signing agreements with agriculture and agri-foods Canada to offer some sort of pilots in a targeted region in Ontario, but that is still something in development.</p> <p>Mixture of government funding and private funding is needed.</p>
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4.2 Common Strategies- What additional secondary research is needed?

As the concept of circularity heavily revolves around three common waste management strategies as highlighted prior, there was general discussion of each regarding feasibility and current implementation in Canada. By understanding what strategies are currently in place now, and how they have been received will give us a basic understanding of progress within Canada and the likeliness of implementation in unaffected areas in the future. Common themes and general knowledge that emerged within discussions are highlighted in the following tables below (Table 17).

Table 17: Common Strategies discussed in Interviews (Canadian Perspective)

Strategy Presented: Extended Producer Responsibility
BC has a program in place, Quebec is in the consultation phase right now
Useful because ensures efficiency for types of packaging that people are using (collection/management systems)
Individual producers will be paying for what gets recycled, but fluctuating markets are at an all time low right now.
This will likely occur for more in demand materials/valuable materials such as #1,#2, and aluminum before it happens for plastic film
Individual producer responsibility is coming to Ontario, can see this being approved for specific items in the overall system, but not sure about plastic film because of low value and fluctuating market. Could be improved with extended producer responsibility.
Currently no regulations for this under current Provincial Recycling Regulations (BC). There are limited drop off locations in the region for residents under the Recycle BC program.

Strategy Presented: Reduction of Waste Downstream
Plastic tax used (some laws require products to have a certain amount of recycled content when produced)
This system can improve, but plastic film is so ubiquitous this will be tough to accomplish

Strategy Presented: Expanding Recovery Systems
Ontario has a blue bin in place, more capacity than Alberta (have not addressed packaging)
We haven't figured out a way to do this completely yet. Automation is definitely more prevalent, but the systems are still very inefficient. (i.e. machines will blow air to separate film)

4.2.1. Societal Impact on Plastic Film and Packaging Consumption

Each changemaker is also a consumer. By understanding why society continues to consume plastic film and packaging and social influences that surround this commodity (Table 18), we can identify relevant substitutions and the feasibility of a single use plastics ban as a part of the transition towards a circular economy.

Table 18: Societal Reliance on Plastic Film (Summary)

Factor	Why is society reliant on plastic film/is it necessary for the functionality of Canadian Society?
Data Set	Impact
Industry Expert	They are very relevant today because plastic is such a versatile material. It has great characteristics that we are going to move away from. Issue is that plastic is very cheap. Price of plastic does not take into consideration externalities (i.e. environmental impact). Life management is not considered and that is problematic. We are in a situation where the public drives these numbers and any change right now.
Industry Expert	Film is very convenient. They are necessary for functionality in certain areas, don't know another way around single use in health care. Necessary until there is a breakthrough in disinfecting reusables. Food production: need to keep everything fresh/safe from bacteria, although in farmers markets there are a lot of reusables. In a globalized world it is more necessary, but in Canadian society, the more we can localize systems will have a greater impact.
Processing Plant	It's clean, cheap and easy to use. It would be considered a need in our society. Depends on what part of the world you live in to whether film would be a cultural/social influence. Ours is different compared to Asia or Europe.

Industry Expert	Film is convenient and inexpensive. As recycling evolves, society will look to more sustainable methods of packaging, the necessity to rely on these products should be reduced.
Agriculture Waste Management Organization	Where we really focus is end of life management. We're not an advocacy organization, but when it comes to farming and plastics, they are a tool. They will help get a product from retail to a farm and help with storage. Plastics help with supply chain management and that is something that we have seen with the start of COVID-19. Farmers have been able to get products from point A to B in a cost effective manner. The value of what you would get out of plastics from a farmer's input versus consumer at a grocery store (single use) is different.

4.3 Secondary Data Collection: Operations

Primary data collection sought to identify key influences throughout the entire plastic life cycle that enables linearity within the Canadian economy. However, there were a few gaps in knowledge that were prevalent. The following sections will present key information identified through secondary data collection with the aim to provide additional insight unable to be attained from the interview process. This is accomplished through a review of reports as outlined previously in Chapter 3.

4.3.1. Materials Recovery Facilities

A common idea that was touched upon in discussions with both materials recovery facilities and processing plants was the need for investment and subsidies for programs in the secondary material market to stay competitive with virgin plastic producers. This was a prevalent intervention as found in international case studies as well. Investments must be made throughout the entire plastic value chain from manufacturing, distribution, disposal and reprocessing, in addition to investments into secondary plastic markets to sustain economic prosperity for both recyclers and processing plants. According Shedler (2017), 2016 saw the largest failures of post consumer plastic plants since the 1990's. This failure was attributed to little to no cost advantage from post consumer plastic plants in comparison to virgin producers. Throughout the years, there has been investments into virgin resin productions such as the introduction of shale gas infrastructure, effectively lowering operational and production costs. Previously, the fluctuating costs of oil levelled the playing field for post consumer plastic producers and virgin resin plastic producers. However, the cost of oil is estimated to rise over the next few years.

The following are business fundamentals in the plastic industry that see post consumer plants weaker in comparison to virgin producers: access to raw materials, the quality of raw materials, contract security, transportation cost, manufacturing/processing costs and market demand. Fluctuating factors such

as: energy pricing, Chinese and other international export demand, transportation costs, and collection state all influence the success of the post consumer plastic recycling industry.

Secondary markets for plastic film will likely be the most impacted by shale gas investments and the National Sword policy. Market options are already limited for plastic film due to low value, low collection and contamination issues. Clean shopping bags obtained from recycle drop off locations can likely still be marketable as this material can be easily pelletized and resold, however, the reality is that most plastic film that enters the waste stream will be dirty and unusable. Outside of use for convenience purposes, plastic film is used as personal protective equipment or for food safety and transportation. Most secondary materials will come from materials recovery facilities and blue box collection programs however, the collection of plastic film is rare as is because it is hard to regulate film collected in community programs. Residents are left to determine what is deemed appropriate for recycling, with few being knowledgeable on what levels of contamination is considered acceptable.

However, like with investments in virgin resin producers there needs to be equal investments in improving post consumer plastic processes and markets. Plastic waste is considered an economic problem. There is a lack of alternatives that are less wasteful similar in price to virgin plastic products. According to the Report of the Standing Committee on Environment and Sustainable Development (2019), Usman Valuante of Smart Prosperity Institute:

“We've got this fundamental disconnect in economics between virgin plastics and plastics that end up as waste and recovering those plastics. Why is plastic so cheap? Some are due to direct subsidies that we give for fossil resources. The plastics manufacturing sector is very large; it has large scale efficiencies; it's integrated into the oil and gas sector; it's part of the petrochemical sector. To give you some idea of scale, again, these are numbers that came from Deloitte.... The virgin plastic production sector is 30 times the size of the recycling industry in Canada today. That will give you an idea of the scale efficiencies that exist for the production of virgin plastics. Then we have disposal, which is unpriced, so today you can dump plastics into the landfill and there's very little cost for disposing of it or sending it to energy from waste.” (p. 21)

- Aldrag (2019)

A search for subsidies available for the secondary plastic market came up with no public results in comparison to an estimated \$600 million per year devoted to fossil fuels that drive the petrochemical industry (Corkal, Levin & Gass, 2020). Funding may be available from private organizations that have an interest in single use plastics waste management and secondary plastic markets.

When looking for provincial leaders in recycling, we can look to British Columbia for an example of successful extended producer responsibility and product stewardship programs. Their success can be attributed to the following factors: low contamination rates, high product quality and shifting the responsibility for funding programs to producers (Johnston, 2019). This allows materials recovery facilities and processors to operate at a more effective rate than in comparison to others in different provinces or municipalities that may struggle with contamination issues. With clean sorted plastics, processors can resell at a higher value and materials recovery facilities can lower operating costs with reduced labour requirements allocated towards additional sorting. In a highly competitive secondary plastic market, the quality of materials collected is important for resale value. Considering the National Sword policy implemented by China, other countries are following suit and closing off imports for plastic waste. This tightens the market and allows buyers to be more particular about the products that they choose to accept. As is, plastic film is a low value commodity with limited markets available.

Currently, Ontario recycling programs are funded through municipalities and in turn, taxpayers. Proposed frameworks are in place to shift the responsibility of the Blue Box program to businesses instead of consumers which will see to it that those who are producing and providing plastic packaging will be responsible for the management of it at the end-of-life cycle, looking towards an extended producer responsibility strategy. As it stands, not all Canadians have access to recycling programs. Approximately 90% of Canadians live in areas with some plastic recycling, with programs varying depending on location. This variability is impacted by the cost and availability of recycling infrastructure, in addition to barriers imposed by lack of technology available for hard to recycle plastics, such as film (Aldrag, 2019).

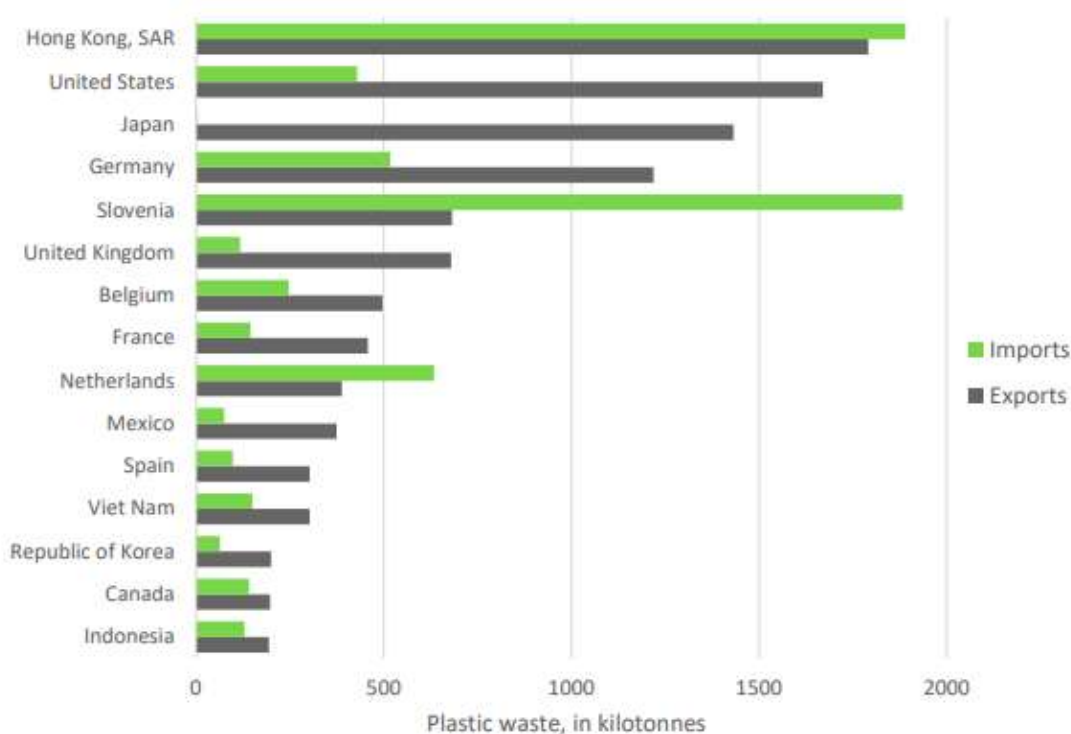
The average price of mixed plastics in Ontario including film range from \$101/tonne to as low as \$37 per tonne. More rigid plastics such as PET and HDPE can sell for as high as \$488/tonne to a low of \$363/tonne, and as high as \$579/tonne to a low of \$497/tonne, respectively. When in comparison, operating issues that plague sorting machinery in materials recovery facilities along with labour costs associated with

collecting film outweighs the benefits of collecting the low value commodity (Essex-Windsor Solid Waste Authority, 2019).

4.3.2. Landfill Operations (including waste management industry experts)

With international markets limiting or closing off their plastic imports completely, recyclers are left scrambling trying to find new markets for plastic waste. In 2018, the amount of plastic waste exported was slightly under 100,000 tonnes when approximately 380,000 tonnes for plastic waste was collected. This figure is down from 150,000 tonnes exported in 2016. Although there are some local markets, this likely led to most plastics collected being landfilled. This decrease is attributed to the tightening of Chinese import regulations which set out higher standards for materials collected. Although it is highly unsustainable to rely on a single country to process all plastic waste, the reality is that the amount of plastic waste China imports is significant in comparison most countries (Aldrag, 2019).

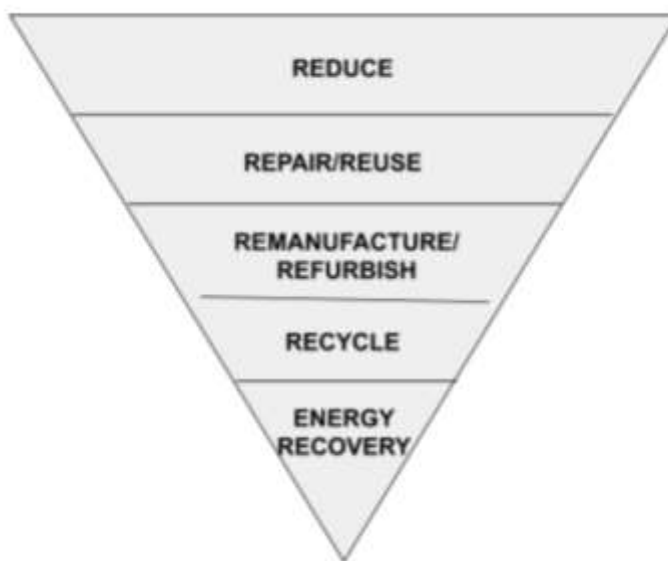
Figure 3: Plastic Waste Imports/Exports according to Country



Note. From Aldag, J. (2019). *The Last Straw: Turning the tide on Plastic Pollution in Canada*. House of Commons Canada.

The strategy presented by the CCME puts forward a hierarchy of priority in plastics waste management. The most preferred method for plastic waste management would be to prevent plastic waste from the start but using plastic waste as a form of energy recovery if needed. Each method in the hierarchy leans towards a circular economy mindset, looking to reintroduce existing plastics back into society in some form or function.

Figure 4: Waste Management Hierarchy



Note. Adapted from CCME. (2018). *Strategy on Zero Plastic Waste*.

After a review of relevant municipalities in the Southwestern Ontario region with public landfills, it is clear that there is a lack of consistent information available (Table 19). Information compiled had to be pulled from an average of two sources to gauge a vague understanding of single use plastic waste composition in landfills. This is consistent within the global waste management industry, as little public information on waste composition overall or the concrete numbers on effectiveness of strategies is available (i.e. Rwanda, Philippines). As discussed by Aldrag (2019), there is currently no standardization that exists in the industry with regards to data collection, composition, etc. and this remains a weakness in current waste management strategies that must be addressed on a national level. While it is more efficient to have most jurisdictions operate their own facilities, implementing standardization in data collection can help determine if strategies are working as intended. Overall waste composition may be hard to track granted

the nature of garbage collection but is more possible if better sorting processes are implemented (whether through more education, technologies, etc.) for both consumers and materials recovery facilities.

Table 19: Single Use Plastic Makeup According to Municipality

Region	Approx. Single use plastics Makeup in landfills or diversion rates	Initiatives Implemented/ Strategies to be investigated
City of London	<p>Film is not accepted curbside- as of 2016 approx. 3,321 tonne/yr enters the waste stream.</p> <p>Estimated that by 2025, this figure will rise to 3,554 tonne/yr.</p> <p>No plans to include film in blue box collection.</p>	<p>Public outreach/promotion program, training of key program staff, optimization of collection operations, established/enforced policies that induce waste diversion (i.e. bag limits), enhancement of recycling depots, provision of free blue boxes, collection frequency, optimization of processing operations and materials being collected, multi-municipal collection and processing of recyclables, standardized service levels and collaborative haulage contracting,</p>
Windsor Essex-EWSWA	<p>No public information available on film waste composition.</p> <p>In 2010, 6.7% of waste in landfills were composed of recyclable plastics.</p> <p>Non-recyclable plastics such as film were included in other refuse, which accounted for 20.8% of landfilled materials.</p>	<p>School/community presentations, special community events, public education initiatives, gold star program</p>
Waterloo	<p>No public information available on film waste composition.</p> <p>Film collected curbside.</p> <p>Approximately 63% of film recycled is properly captured.</p>	<p>Standardization of waste programs, modified depot drop offs, bi-weekly garbage collection, bag limits, user-pay systems, promotion/education</p>
Hamilton	<p>No public information available on film waste composition.</p> <p>Hoping to divert 56 - 60% of film by 2021 in blue box programs</p>	<p>Targeted education, focus on commercial sector, add new materials to collection programs, continued EPR, multi-municipal processing, single stream processing</p>

<p>Niagara-Humberstone</p>	<p>5.25% of landfilled materials were recyclable plastics, no data available on the composition of plastics in the garbage waste stream.</p>	<p>Media releases (marketing push), neighborhood campaigns and audits, newsletters, composition audits, educational videos, regular meetings with collection contractor</p>
<p>Toronto - Green Lane</p>	<p>No public information available on film waste composition. Film offered in curbside collection; however contamination issues are very common.</p>	<p>Reduction of single use items, community reduce/reuse programs, TO waste app, Artist in residence pilot program, waste reduction grants</p>

When discussing single use plastic waste in landfills one-on-one with industry experts and landfill workers, most were quick to comment on the increasing amount of single use plastic waste within their facilities and the issues this causes with equipment along with the growing concern of litter blowing around during transportation. However, this is not something that is acknowledged widely in waste management reports obtained from municipalities. Most reports touched on diversion statistics or discussed waste management plans in the future looking to strategize ways to reduce the amount of garbage collected through the years or best practices. However, a lot of these reports were outdated with most being written in the early 2010s and some municipalities even lacking any formal documentation. Even looking past the scope of plastics, there is a lack of information available on landfill capacity, strategies and processes in general. Each municipality handles single use plastic waste differently, and one common thread is that each city struggles with contamination issues within recycling streams. As a result, contaminated plastics will make their way to the landfill and in turn, taking up valuable space. To address this issue, most looked to community outreach to try and resolve the issue at the source by informing residents who utilize the recycling programs.

As of 2018, residential waste disposal per year in Ontario sits at 3,980 kt and non-residential waste disposal at 6,104 kt with a national average of about 13% waste composition being plastic (Government of Canada Statistics Canada, 2020). These figures show that although residents do contribute to landfill mass, the biggest drivers are the industrial, commercial and institutional sectors.

4.3.3. Businesses (including advocacy groups)

Businesses have a large influence in the status of plastic film waste in Canada. As the manufacturing and industrial sectors are a large contributor to the single use plastic waste crisis, they also have the most potential to drive change within their respective industries. In the report “State of Waste Management in Canada” (2014), there was a large emphasis in shifting responsibility upstream to producers rather than consumers. Two strategies highlighted in the study supported the idea of reduction of waste downstream and extended producer responsibility. By putting the onus on producers to minimize waste at the manufacturing (i.e. establishing best practices in environmental management, utilizing more secondary materials in production, incorporating less packaging, product design) and commercial level (i.e. bulk purchasing policies, limiting single stream disposable products, reuse programs), the amount of unrecyclable plastic film that enters the waste stream is reduced. However, single use plastic waste that does enter the waste stream can further be controlled through extended producer responsibility schemes. In practice, extended producer responsibility in Canada has increased diversion activity however, producers tend to shift the cost to consumers at point of sale.

As of 2014, Ontario does not have any waste reduction initiatives in place. Although a few businesses, notably grocery stores, have taken it upon themselves to impose a plastic bag fee, this is not a regulated fee by the government. Some municipalities have imposed a by-law banning plastic bags, but to date, there are only two Ontario municipalities enforcing this (Table 20). A few provinces have taken initiative to develop and participate in various initiatives. A few examples are listed in the following table (Giroux, 2014):

Table 20: Waste Reduction Initiatives by Province

British Columbia	A report is commissioned for the case of zero waste in businesses, this will help to drive and guide government in determining the next steps in waste prevention and management
Alberta	Government agreement with major retailers to reduce the distribution of single use plastic bags, an annual goal for per capita waste disposal targets is set
Manitoba	Funding available for waste reduction projects, government set goal to reduce plastic bag usage and increase beverage container recycling
Quebec	Government agreement with IC&I to reduce waste upstream at the manufacturing level. Annual disposal limit for waste disposal per capita.

Nova Scotia	Sustainable procurement policy for government purchasing in place. Annual disposal limit for waste disposal per capita.
Yukon	Funding available for waste reduction projects.
Northwest Territories	Government set goal to reduce plastic bag usage

Note. Adapted from Giroux, L. (2014). *State of Waste Management in Canada*.

Although there are a few legislated extended producer responsibility programs in place, none of these focus on hard to recycle plastics such as film or packaging. However, the Blue Box Program is looking to shift to a completely producer funded model that if approved, will come into effect by 2025. Changes to the program including a larger scope of materials accepted, larger diversion targets, material specific targets and specific funding allocated to hard to recycle plastics (i.e. film) collection will be implemented. This will allow for more consistent recycling standards that do not exist today. While some municipalities collect film, this will standardize recycling across Ontario to either accept or reject certain materials (Stewardship Ontario, 2021).

Legislated extended producer responsibility programs now only include electronics, hazardous waste and automotive materials. However, product stewardship programs do exist for the agriculture sector to deal with related waste materials (i.e. grain bags). Most programs often start and are successfully sustained when there is government backing or support. While the industrial, commercial and institutional sectors are large contributors to plastic waste, there are little to no programs found to help support plastic film and packaging waste management within it.

The CCME was working on a Canada-wide initiative to develop an industry driven approach to reduce non-recyclable packaging, reduce green house gas emissions and increase recycled content in packaging. However, a 2012 study conducted by Metro Vancouver in collaboration with the Federation of Canadian Municipalities found that stringent regulations do not necessarily drive innovation within the industry. Governments that were clear in their health and environmental objectives, including disclosure of limitations of public funds for waste management saw positive results from businesses looking to prevent waste. This study sought out to establish ways the industrial, commercial and institutional sector could prevent waste (upstream) and encourage consumers to consume less (downstream). Some

recommendations included using marketing to encourage bundling, price changes and developing incentives for consumers to share or use second-hand (Giroux, 2014)

Federally, single use plastics that fall under the criteria of both environmentally and value recovery problematic will be banned, and those that do not will have a production target of at least 50% post consumer resin by 2030. However, the process in which this will be implemented is still under review. Considerations such as recycled content by resin type, product/sector grouping, and an economy-wide content target are viable options. If a recycled content requirement is enforced, this could enhance post consumer resin markets to have a fair advantage over virgin resin producers, as well as encourage innovation within industries to develop more innovative alternatives to plastics.

4.4 What's Next- Stakeholder action needed (Summary of Findings)

Film is considered a problematic material that is largely unaccepted in most curbside collection programs. The amount of labour and resources required to clean and sort plastic film deters most materials recovery facilities from processing the material, granted the high technological capabilities needed versus low market value for post secondary film resin recovered. While markets exist for secondary film, these are very limited especially due to the tightening of foreign markets. This results in 10-15% of landfill space in Ontario being taken up by plastic products that fail to be properly recycled or incinerated. Although film does not take up a significant portion of landfill space, it still takes up landfill capacity and causes issues with equipment while also contributing to litter in surrounding areas from blowing. While the long-term environmental effects of film are still largely unknown, taking proactive action now can deter further damage to the environment and ecosystems. The rise of the industrial generation will only mean that the amount of plastic film produced will continue to grow as manufacturers will look for ways to reduce shipping weights while still being able to protect goods. With no retribution for plastic film waste, producers will continue to exploit plastic resources for convenience purposes and to save costs.

While citizens are continuously becoming more aware of the effects of plastic litter, waste diversion and citizen run groups have found increasing presence over the years. Campaigns encouraging proper recycling can help divert plastic from landfills, however, wishful recycling can also drive consumption when recycling acts as a scapegoat. Consumers have the choice to refuse plastic bags, but the power that

consumers have is limited to personal shopping choices (i.e. buying loose produce, bringing personal bags for groceries, etc.). The power to shift plastic film consumption largely lies with producers or distributors (who may choose to protect their products with plastic film packaging to either prolong shelf life or ensure safe transportation) as consumers are limited to what they are able to purchase.

Ultimately, the government will play a large role in the transition towards a circular economy. Changes in policies such as the introduction of extended producer responsibility, waste reduction or additional funding for expanded recovery systems (i.e. raised through taxation) prove to be valuable considerations. Most recycling programs can be sustained with government resources and funding, however, the likelihood of a self-sustaining program for plastic film without government aid is unlikely. While industrial and commercial businesses are the largest contributors to plastic film production, no government programs currently exist to help manage commercial plastic film waste. Policy actions are likely to occur for more valuable plastics rather than film to begin with. Secondary markets for film are the most impacted by shale gas investments and the National Sword policy as market options are already limited. In the case of plastic film, prevention and reduction of waste will be the most effective method. Further standardization of recycling can also help avoid confusion. Granted that capabilities vary by province; this strategy may be best implemented on a regional basis while slowly working towards national standardization.

An effective circular strategy for single use plastic waste such as film, will require collaboration from multiple stakeholders including but not limited to businesses, government, organizational groups, landfills, materials recovery facilities/processing plants, consumers and government. While social, legislative and economic influences are all important to consider when implementing an appropriate single use plastic waste management strategy, the reality is that market factors and economics play a large role in controlling the amount of plastic film in the environment and government intervention is essential in guiding this discourse. Plastic film is intertwined in everyday life and is unlikely to disappear in both products and packaging any time soon. While eliminating unnecessary plastic film like carrier bags through bans in proposals such as that of Bill 82, plastic film is much more prevalent within industrial and commercial sectors for use in packaging or transportation. Stringent regulations will not drive innovation, but innovation can be encouraged if the government is clear in their objectives (including fund allocations and availability).

Chapter 5 will delve deeper into where priorities should be moving forward, with a discussion on the feasibility of a circularity within Canada for the purpose of preventing and managing plastic film waste. It will tie in international strategies as well as criteria for success as discussed earlier, and where the gaps in knowledge currently lie.

Chapter 5: Conclusion

This thesis sought out to answer the research question: **“What are the challenges and opportunities associated with a circular economy approach to plastic packaging and film waste management?”**.

This was done so through satisfying the following research objectives:

1. Identify what strategies are currently present in a Canadian and Southwestern Ontario landscape and if any with reference to other circular strategies and what contributed to their success
2. Identify any criteria for change (social, legislative, economic)
3. Fill in the knowledge gaps that exist within current plastic waste management strategies using a life cycle analysis, in a Canadian and Southwestern Ontario landscape.
4. Identify barriers to implementation in current plastic waste management strategies

Research objectives were addressed using a combination of qualitative research methodology to contribute relevant knowledge. Starting with an initial literature review of circular waste management strategies found globally, I then followed with primary data collection from interviews (designed to identify the probability of the success of key interventions as determined by the Canadian government) of key stakeholder groups, and filled in the gaps in knowledge using additional documents (publicly available municipal waste reports and government reports). Ultimately, I can draw the following conclusions:

- At the start of life cycle, government intervention is crucial to regulate the amount of plastic film that circulates within the environment. Through various legislative actions such as creating recycled content requirements, funding sustainable alternatives and levelling the playing field for secondary resin producers whether through investments or subsidies, the amount of virgin plastic film produced can be drastically reduced if the focus to invest in petrochemicals is eliminated. Innovation and willingness to collaborate is not driven through stringent requirements, but rather open communication and transparency. In this aspect, the power to incite change will have to move from the government down to industry/businesses, then onto consumers.

- At the end-of-life cycle, while plastic film does not pose a large threat to landfill life film waste is extremely harmful to the environment and ecosystems if not managed correctly. Responsible waste management should be prioritized at this stage. A circular economy strategy will place an emphasis on maximizing the life span of plastics already produced. Introducing extended producer responsibility programs as well as expansion of recycling programs to manage current plastic film waste will be beneficial to reducing the amount of plastic litter in the environment, as well as reducing the amount of virgin film produced. Using economic instruments such as taxation to discourage the overuse of film or banning film waste in landfills will force both industry and consumers alike to think twice about consuming unnecessarily.

While a large emphasis is placed on government and industry collaboration, consumption patterns are also impacted by the consumers themselves. This chapter will discuss where priorities should lie moving forward, reflect on the feasibility of circularity within Canada using criteria established in Chapter 2 along with further insights from key stakeholders from Chapter 4, and detail the impact of societal norms on the implementation of a circular economy. It will identify any gaps in knowledge that need to be addressed and what an appropriate plan of action may look like moving forward.

5.1 Overview

The world is becoming more interconnected with the rise of industrialism and global trade. Plastic packaging used for protective purposes during transportation and shipping has led to an increase in waste generation and plastic litter in our environment from improper disposal and leakage. At the end of life, plastic waste is often exported to developing countries to process, leaving a trail of plastic litter blown during transportation. While the detrimental effects of plastic pollution have been covered in mainstream media, no central international organization has been established to specifically tackle the issue at hand. This makes creating a plastic film strategy much more difficult, as there is no universal agreement on what framework constitutes as the best approach. Given the unique circumstances of each socio-economic climate, customized solutions are required rather than a one-size-fits-all approach. The responsibility is currently shared amongst respective governments, businesses and consumers to manage plastic film waste and reduce unnecessary consumption. Circular economies have been established however, as a

prominent and visible strategy to tackling plastic waste. It has been a strategy reviewed in academia (Stahel, 2016; Esmailian et al., 2018; Nielsen et al., 2019; Geissdoerfer et al., 2017), in Canadian government such as in the CCME: Canada-wide Action Plan on Zero Plastic Waste (2018), and in global reviews such as in the EU Action Plan for a Circular Economy (2018). International practical applications of the circular economy can also be seen in places such as in the EU, Philippines and Rwanda. A circular economy approach to plastic film waste management requires a change in mentality from producing in excess to sufficiency. Using global case studies, we were able to identify what interventions are required to support behavioural changes and innovation throughout the value chain. The responsibility of upkeeping and establishing circularity is likely too large of a task for one organization to take on without regular contributions from government, industry experts and academia. However, circular strategies have been found to be effective when divided amongst smaller regions to mandate, enforce and implement. Advancing circularity will still require a combined effort from all stakeholders.

Some common ideas and gaps identified from primary and secondary data collection are highlighted in the table below, as well as additional questions that need to be discussed further (Table 21).

Table 21: Gaps in knowledge according to Stakeholder

Stakeholder Group	Summary of Concerns/Ideas	Questions to be Addressed
Materials Recovery Facilities	Voiced the need for subsidies to help stay competitive within the industry	What subsidies are currently available to help support secondary markets? What additional investments would be required within the post consumer resin industry, and throughout which relevant life cycle stage?
Landfills	No universal database available, each landfill has access to their own records. <i>(Note: only a few waste management professionals could participate- not every landfill within Southwestern Ontario was covered)</i>	What is the single use plastic make up in other landfills? Would a universal database help/harm the transition towards zero plastic waste in the future? Is this feasible?
Businesses/Advocacy Groups	No public records available. Each industry operates differently, and the private nature each business means that concerns will be unique to each industry/business owner.	Are there waste reduction initiatives available for businesses? What factors drive businesses to be large consumers of single use plastics?

The implementation of a circular economy within Canada to tackle plastic pollution should be taken from a regional approach and scaled upwards. Currently, waste management is largely the responsibility

of each respective municipality, but under provincial guidance. Although this has been somewhat effective given the differing capabilities of each region, this approach can lead to conflicting visions if regional agendas differ. With this consideration, regional inputs should be used as solely a starting point prior to standardization of waste management systems. After the fact, if the federal government is clear with its goals and environmental objectives, the roll out of an overarching plastic film waste management plan will be easier to retrofit to existing strategies. Currently, the government of Canada has announced their intent to move towards zero plastic waste. However, the most visible plan of action is an intent to ban six single use plastic items which will be enforced only if economically feasible. This is not enough. There should not be a trade off between economic prosperity and environmental stewardship. More evidence-based decision making is needed to move plastic film waste management and strategy forward.

5.2 Feasibility of Circularity, Barriers and a Reflection throughout the Plastic Life Cycle

Circularity within Canada as a means of plastic film waste management is a concept that requires a combination of multiple strategies such as extended producer responsibility, reduction of waste downstream and expansion of recovery systems. Sustainable plastic film consumption and waste management can only be achieved if there is a collective desire for a shift towards sufficiency and a cradle-to-cradle philosophy from consumers, businesses and government. There is no universal solution as each region has its own unique set of challenges and opportunities. In the case of Rwanda, a complete plastic ban to transition the country towards circularity was feasible due to the lack of influence that corporations held within the country. The government was able to emphasize the importance of circularity to both economic and citizen health. This meant coming to a collective understanding that eradicating plastics leads to healthier crops, wildlife protection and natural disaster prevention such as flooding. There are now no primary plastic bag production industries (production), plastic film usage is restricted to necessary purposes only (consumption), and responsible plastic film waste management is done through five major recycling centers that reuse post consumer materials (disposal) (Whyte et al., 2020). The government was able to pivot economic strategy to focus more on service-based businesses and continues to invest in green industries, as well as the private sector to improve operating climates for the industry. Being a country that at the time was still recovering from the emotional and economic turmoil brought on by the Rwandan

genocide, rebranding the nation as free from plastic pollution drew in investments to grow their tourism and hospitality industry as well as paint a picture of new beginnings. This is just one example of how opportunities in plastic waste strategies will differ from region to region.

In Canada, the largest barrier to achieving circularity is the dominance of linear plastic business models within the country. Goods produced to be short-lived and disposed of will make more money from requiring consumers to repurchase more frequently. Current economic and policy conditions allow for cheap production and disposal of unnecessary plastics with influence that oil and gas companies have within the country. Over the last five years, the energy sector has brought in an average of \$14 billion in revenue for the Canadian government when considering corporate income taxes, indirect taxes and both crown royalties/land sales in addition to over 10% of all operating revenues for the Government of Canada. Petroleum accounts for approximately \$8.16 billion, or 5.3% of Canadian nominal GDP and 0.9% of employment within Canada (Government of Canada, 2020). The economic contributions that fossil fuels bring into the country will make it difficult to convince policy makers and economists alike to move away from reliance on non-renewables. There should be no trade off on what function will require fossil fuels next in a bid to keep Canada prosperous.

While the world continues to become more aware of the climate crisis and detrimental effects of oil, gas and non-renewable energy, the plastic crisis is seen as an entirely different issue that lacks urgency. The most visible case of this can be seen in the case of the UN Sustainable development goals. Plastic waste management and overconsumption is not recognized as an issue to be targeted in a sustainable development goal. While climate change continues to be a large area of focus as highlighted in Goal 12: Responsible Consumption and Production and Goal 13: Climate Action, what lacks to be recognized is how global plastic reliance contributes to increasing fossil fuel reliance. The plastic crisis is largely narrowed down to poor waste management. While Goal 14: Life Below Water comes close with the mention of human activity and its impact on surrounding marine eco-systems, little is mentioned on plastic dependency throughout other stages in its life cycle and those impacts to the environment. Highlighting marine plastic pollution as a main driver to the plastic crisis suggests that the issue solely occurs at the end-of-life cycle and can be resolved through clean ups or better waste management. However, the plastic crisis is largely

ignored throughout the production and consumption phase. This leads to a false narrative that plastic dependence is acceptable if appropriate waste management measures are put in place to prevent plastic leakage. The responsibilities then fall upon consumers to dispose of their waste properly, and for governments to manage it rather than for businesses to be more conscious of their plastic use. More awareness is needed on the impacts of plastics throughout the entire life cycle to not only ecosystems, but human health and climate change as well.

The difficulty in formulating an argument against plastic especially in a climate where COVID-19 is still a concern, is the constant emphasis placed solely on the benefits of plastics without considering the detrimental impact that the material plays on the environment and surrounding eco-systems throughout its entire life cycle. Single use plastics are often portrayed to be hygienic, affordable, efficient and convenient. The use of plastic film is so universal that it can be found in almost every household, commercial establishments from grocery stores to restaurants, and in most packaging for common goods. Often, plastic film is forced onto the consumer without having been asked if it was wanted to begin with. Manufacturers and businesses hold the power during the consumption stage in a plastic life cycle. While citizens can choose to use their buying power to reduce the amount of plastic film consumed, ultimately the amount of plastic film that circulates in the environment is determined by those who produce and distribute it. Without a viable substitute for certain essentials, they will have to settle for products that come packaged in plastic. Plastic film has its place in protective functions where otherwise no alternative has been identified. Plastic film does not have a place for convenience purposes such as for use in packaging where a suitable alternative may already exist. Legislation would be required to regulate and entice industry to eliminate virgin plastic film production, while stimulating the secondary plastic film industry where substitutes for plastic film are not yet possible. However, both plastic alternatives (i.e. paper/cardboard) and post consumer resin products come at a higher cost. For this to be economically sustainable especially for small businesses, the government must subsidize packaging costs for businesses requiring alternative packaging in addition to encouraging investments within the post consumer resin producers to reduce the cost of recycled plastic products overall.

Additionally, for a commodity this widely used and accepted, there is still no waste management plan in place to responsibly manage disposal. There are few outlets available to extend the life of film and/or encourage recycling. This is partially due to film being produced as a low value commodity and designed for single use. This has been especially amplified during the COVID-19 pandemic as single use items were in higher demand due to being seen as more hygienic. Big box retailers waived plastic bag fees and discouraged the use of reusable bags, even to the point of banning them to be brought into establishments. While extended producer responsibility exists for hard to manage and toxic waste such as white goods or electronics, it does not exist for plastics.

The concept of using extended producer responsibility, reduction of waste downstream and expanding recovery systems to transition towards circularity has been a few key strategies discussed in Canada such as in frameworks like the Canada-wide Action Plan for Zero Plastic Waste (2018), Phase 1 (2019) and Phase 2 (2020). However, different kinds of plastics require different processing capabilities. If extended producer responsibility is to be implemented, it will likely be for higher value plastics such as HDPE first. As film is a low value commodity due to the fact that it contains a mix of plastics hard to separate and process, it will likely be ignored. Without stimulating discussion and raising awareness on how to properly manage plastic film, it will be forgotten. As mentioned earlier, plastic film waste is an economic issue and as such, economic instruments will be valuable in the transition towards circularity. With the tightening of foreign policies restricting plastic waste imports, secondary plastics markets will suffer due to low quality inputs and buyers being more selective with their material. This is especially applicable to secondary film markets, as the market is already virtually non-existent with current post consumer resin markets being largely supported by legislation elsewhere mandating recycled content requirements. Markets for recycled plastics are low, and even more so for recycled film resins making it cheaper to dispose of film rather than to collect, clean and process the material.

Through an analysis of global case studies carried out in Chapter 2, we can determine that a circular economy requires improvements in several stages of the plastic life cycle. A circular economy requires the following to be successful:

- an innovative sustainable plastics industry (where both design and production fully respect the need to reuse, repair and recycle) as well as
- the combined support of government, industry and citizens (providing room for sustainable and safe consumption/production).

Interventions need to be targeted towards slowing down production of plastic film, discouraging unnecessary plastic film consumption and ensuring that there is a waste management plan in place to handle film where otherwise an alternative is not readily available.

5.3 Optimal Solutions and Implementation Plan

The proposed single use plastics ban in Canada is an oversimplified solution to the plastic crisis. This comes with the assumption that all single use plastics can be handled in similar ways. Single use plastics are often grouped together as “one issue” even though each commodity poses unique challenges and require specific solutions. Plastic film waste is a multi-faceted issue, it will require collaboration from multiple sources from governments, businesses, to consumers. An optimal strategy will be driven by legislation, encouraged by businesses and received by consumers. Moving top down, governments need to reinforce the ideology that plastic film consumption is unnecessary. Policies targeted towards businesses to produce less film will eventually move downwards to reducing the amount of film consumed by citizens.

Using criteria established in Chapter 2 through global case studies, in addition to insights gathered from industry stakeholders and literature to fill any gaps in knowledge, the following implementation plan (Table 22) should be considered to successfully transition Canada towards circularity:

Table 22: Canadian Implementation Plan for a Circular Economy

Influence	Criteria	Priority Rank	Relevant Life Cycle Stage	Concerns Addressed
Legislative	Establish indicators to track progress, with regular reporting to a third party	High	Production, Disposal	Landfills: Universal database is required to track any progress and to better collaborate/integrate within provincial systems

Legislative	Enforcement of taxes, fines and levies for non-compliance	High	Entire	Landfills: Single Use Plastic makeup in landfills cause logistical issues
Legislative	Collaboration between both industry and government, whether through a mutually agreed upon representative or enacted ministry	Medium	Production, Disposal	Landfills: Universal database needed Businesses/Advocacy Groups: No public records available
Social	Community consensus to fight against plastic film waste litter	Medium-High	Consumption	Businesses/Advocacy Groups: Waste reduction initiatives needed
Social	Collaborative innovation from both community members and business	Medium	Entire	Businesses/Advocacy Groups: No public records are available- each industry operates differently; concerns are unique to each industry, and it is hard to collaborate without
Economic	Investment throughout the entire plastic value chain (manufacturing, distribution, disposal, reprocessing)	High	Entire	Materials Recovery Facilities: Subsidies are needed to stay competitive
Economic	Investment in R&D for plastic alternatives	High	Production	Businesses/Advocacy Groups: Affordable alternatives are needed
Economic	Investment into secondary plastic markets	High	Disposal	Materials Recovery Facilities: Subsidies are needed to stay competitive
Economic	Viable and accessible alternatives to single use plastics for both consumers and businesses	High	Consumption	Businesses/Advocacy Groups: Waste reduction initiatives needed

5.3.1. Solutions in Legislation

In legislation, Canadian packaging and film management standards significantly impact the amount of plastic film present in the environment. With no control standards in place, there is no reason for businesses to consume less plastic or use more responsible packaging. Since plastic packaging is 18x cheaper than paper alternatives, most businesses will likely opt for a more economical alternative. This will

be especially true for small businesses that have fixed operating costs, with no expendable funds to invest in sustainable packaging. While the cost to purchase film is low, the cost to manage its waste is not.

There is currently no suitable alternative for necessary plastic film applications (e.g., food protection, healthcare), and the government must intervene to level the playing field between virgin plastic manufacturers and post consumer resin manufacturers. There is an abundance of plastic film that is produced in our environment to date. To avoid additional detrimental resource extraction, plastic film waste should be used as inputs to fulfill film production in instances where a substitute is not yet available. Reintroducing recycled materials into packaging can help reduce packaging costs. Recycled materials will be cheaper than virgin materials depending on volume and end use, along with facilities available at each processing centre. This means that there must be investment targeted towards increasing processing capabilities. Additionally, using economic models to reflect the cost of plastic film to the cost to the environment will reinforce the ideology that plastic film has hidden costs outside face value.

A secondary market for film must exist to manage the amount of plastic film that already exists. Currently, most recycling centers choose to exclude film due to limited processing capabilities and high logistical costs. The cost to manage film outweighs most returns from selling off the material. Sustaining the secondary market for film requires government intervention in the form of subsidies or policy changes mandating the use of recycled materials. This can be completed through the implementation of minimum recycled content, taxation on virgin film use, higher landfilling costs or a film ban in landfills, and the implementation of extended producer responsibility to put the onus on manufacturers/businesses to manage and divert film waste.

A large difference between the EU circular economy action plan and Canada's plan is that there is little discussion over the application of frameworks. There is no discussion over national authorities and enforcement of sustainability requirements or how market surveillance actions will work. Promoting the use of digital technologies to track, trace and map resources in addition to creating labelling requirements can help smooth the transition towards circularity. Strict enforcement, measurable indicators and task forces must be implemented to ensure compliance in addition to improved data collection to track progress and to pivot strategies if needed. Stringent requirements may not drive innovation within the industry, but if the

government is clear in their objectives to improve health and environmental standards (including disclosure of funds available for waste management and how policies will be developed and enforced), businesses may look more favourably to improving operations to match.

The issue of plastics in landfills is also gaining traction in mainstream media. This is especially highlighted in reports discussing recycling rates in Canada (i.e. Canada-wide Action Plan on Zero Plastic Waste Phase 1, Economic Study of the Canadian Plastic Industry, Market and Waste, etc.), emphasizing the amount of plastics that are disposed of. While the number of plastics in landfills is increasing, there is little being done to divert the waste elsewhere or discourage use in general. Historically, lack of landfill space pushed municipalities to adjust their policies accordingly. While film does not necessarily take up a large amount of landfill space, it continues to pollute the environment and endanger eco-systems when it blows, arguably causing more harm than heavier plastics. Bans on problematic material in landfill space will encourage consumers to find alternative means to reduce usage and manage film waste produced. For municipalities with current landfill bans, plastic waste per capita dropped.

5.3.2. Solutions in the Canadian Economy

The objective of a circular economy is to maximize value at each point in a product's life. The focus must be placed on business and industry collaboration to produce less plastic, create more durable goods, and rally public support for sustainable consumption. However, a large driver to how warmly policies will be received collectively is how they will impact the economy and businesses. In the case of the single use plastics ban proposed in Canada, implementation will only occur if economically feasible. The presence of the idea that there can be a trade off between environmental protection and economic health is detrimental to progressive action. The fear incited behind the "potentially negative" effects to the Canadian economy due to the financial impacts to the petrochemical industry, or small businesses from increased operating costs propels the narrative that plastics are necessary for survival.

Fossil fuels continue to be marketed as a valuable Canadian resource with heavy investments both from government and corporations into the industry at the expense of the environment. The federal government continues to partake in contradictory actions such as the announcement of a single use plastics ban in addition to "eliminating" inefficient subsidies, all while allocating funds towards development,

infrastructure and exports of fossil fuels. While energy demand slowly leans away from fossil fuels, the fossil fuel industry continues to invest efforts into other markets hoping to capitalize on different petrochemical commodities. Current investments into oil and gas in Alberta are estimated to grow demand by 4%, while current ethane supplies remain at a five year high (The Canadian Press, 2020). This will lead to an ample supply of plastics regardless of if there is demand. Virgin plastic industries continue to prosper at a market size 30x that of post secondary resin. These actions continue to harm secondary markets and encourage plastic reliance when plastic commodities remain accessible in comparison to other alternatives. If a portion of the \$600 million per year of fossil fuel investments can be allocated to film alternatives, education, better collection/processing capabilities or even subsidizing environmentally friendly packaging costs to small businesses, Canada may be much further ahead in the fight to eliminate harmful plastic film waste.

While the world is becoming increasingly aware of the detrimental effects of fossil fuels as a source of energy, the oil and gas industry has pivoted to capitalize on plastics in the age of convenience, industrialization and rising concerns of contamination granted the current COVID-19 crisis. Additionally, the pandemic has harmed small businesses that have already been struggling to stay afloat. Continued investment into the petrochemical industry has made virgin plastic film much more affordable given the ample supply available. Economic plastic options will triumph over environmentally friendly options if protective benefits are equal, if not better. When no price is placed on the effects of unnecessary single use plastic film consumption, businesses and consumers will continue to use plastic film without seriously considering the repercussions that come with the production, consumption and disposal of the material. Single use plastics may be vital in instances such as healthcare or food safety, however, the use of plastic film beyond necessary circumstances needs to be eliminated entirely. If the cost of plastic film rises, businesses will be forced to identify an alternative or pivot operations.

Additionally, secondary markets are most impacted by shale gas investments. With nothing enticing businesses to purchase recycling materials or more environmentally friendly packaging, business will continue as usual. More money needs to be put into sustaining recycling programs for the film that already exists to ensure that affordable alternatives are available. Most recycling programs will require government funding to be started and/or sustained. This can be seen in agriculture and grain bag waste management.

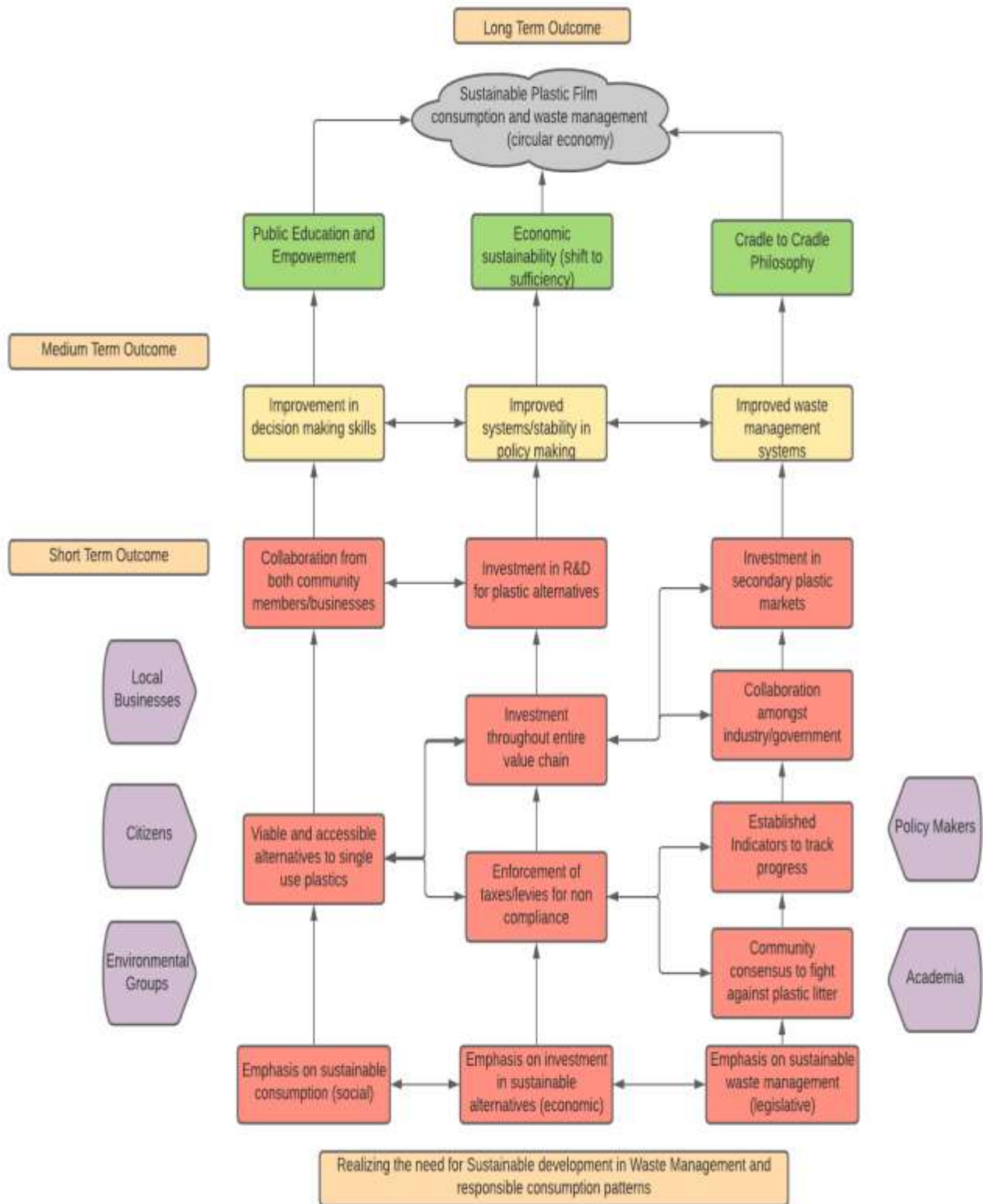
Recycling programs only exist in Manitoba due to government funding, while grain bags in Ontario end up landfilled. Plastic film packaging is a more affordable option in comparison to other alternatives such as paper or cardboard. Pricing and market conditions remain an external influence that can be used to sway the behaviour of both consumers and businesses when it comes to plastic consumption.

To reduce carrier bag usage on the consumer level, economic models such as plastic bag levies are voluntarily imposed by businesses (i.e. big box grocery stores). This has proven to be successful in various circumstances globally. However, the cost of plastic bag levies and taxes are passed onto the consumer with little incentivizing the company to reduce plastic in other parts of operations. Many businesses in Ontario have slowly pivoted to becoming “plastic free” and offering reusable alternatives at a cost, however, a challenge here will be to avoid replacing one single use commodity with another. Globally, there is still no universal breakthrough that can eliminate plastic film in its entirety, however, industries can help manage existing and future film waste by creating a form of standardization. By keeping necessary film packaging universal, recycling centers will have an easier time sorting and determining what processing capabilities are required to manage the materials. Currently, the lack of industry standards gives manufacturers complete power to control the amount of film produced in the environment.

5.4 Theory of Change (Impacts of Societal Norms on Consumption Patterns)

Using a theory of change framework, the long-term goal for sustainable plastic film waste management can be accomplished through circularity. Short term and immediate actions are required to spark progress, such as the criteria outlined in Chapter 2 developed from successful global case studies with the assumption that similar outcomes can be achieved in Canada contingent upon the socio-economic climate. Social, legislative and economic factors all play a role in the success of the transition towards circularity, with influences ultimately coming from various stakeholders such as local businesses, citizens, environmental groups, policy makers, and academia. Overall, each intervention will lead to improvements in decision making skills of consumers, systems and stability in policy making, as well as improved waste management systems. When the entire community can evolve societal norms in a way that reduces consumption patterns due to public education and empowerment, economic sustainability, and the acceptance of cradle-to-cradle philosophy, sustainable plastic film consumption and waste management can be achieved using a circular economy framework (Figure 5).

Figure 5: Theory of Change



While circularity relies largely on manufacturers to reduce film production and legislation to enforce waste reduction initiatives at the production stage of a plastics life cycle, consumers significantly impact the effectiveness of waste management and recycling strategies at the disposal stage. Industrial recycling has been managed well in the past; however, residential recycling remains weak. If residents can correctly follow recycling guidelines, the transition towards circularity will be more effective than solely relying on legislation to incite change. A large contributor to poor recycling rates is contaminated or dirty plastics, attributed to lack of education at a consumer level. Due to the functional nature of plastic film, keeping film clean is a difficult task in most instances. When looking at the recycling system entirely, misinformation about what can/cannot be recycled lead citizens to recycle dirty plastics that contaminate the entire stream. While many municipalities have targeted campaigns towards anti-littering or clean up campaigns, there should be a larger focus on waste diversion and responsible film waste management. Additionally, if a plastic film ban can be implemented based on what constitutes unnecessary and necessary usage, responsible management of necessary plastic film needs to be considered a key focus to prevent further damage to the environment and ecosystem.

Consumers are easily swayed by the environment around them, including who they choose to surround themselves with in addition to what is continuously being displayed in mainstream media. Educational campaigns condemning the improper use and disposal of single use plastics can prove to be beneficial in contributing to the narrative that they are unnecessary. While we can try to reduce plastic consumption, ultimately modern society is dependant on plastic packaging sustained by businesses and producers. A trip to the local grocery store will see produce wrapped in plastic film. Online packages will come protected in plastic film or air bags to prevent damage upon transportation. A large issue contributing to excessive plastic production and consumption is the concept of “wishful recycling”. Canada generates the most waste per capita with an average of 10-15% of landfill capacity taken up by plastics largely displaced by unsuccessful recycling efforts. Both manufacturers and citizens justify unnecessary plastic consumption with the idea that plastics can be infinitely recycled into new products. While recycling is crucial for circularity, the idea that plastic use is sustainable through recycling is damaging. There needs to be more conversation amongst the public on how to reduce plastic film waste. General use of plastic film is not essential. Policy implications like bag levies or bans play a role in reducing film consumed but the

amount of plastic in our environment is impacted by more than just reducing the amount of film consumed. How citizens react to policy changes will play a key role in the overall effectiveness of film waste strategies. Without compliance and willing efforts to make small changes in lifestyle to help reduce the amount of film consumed, the transition towards circularity will be difficult.

5.5 Broader Perspectives and Future Research

Sustainable consumption of single use plastic film and responsible waste management requires unique interventions tailored according to both the geographic area and type of plastic waste. While this thesis solely focuses on the effects of plastic film throughout the entire life cycle in a Canadian context, specifically Southern Ontario, insights provided aim to raise awareness about the complexities behind crafting plastic waste strategies while providing a framework for future strategies targeted towards other single use plastic items. The movement to eliminate single use plastics such as film is important to prevent environmental degradation, however, it is equally as important to emphasize the need to evolve lifestyle habits to steer away from overconsumption and material reliance entirely. Policies looking to reduce film consumption, in general, have their place in within a circular economy. However, while taking away access to certain single use plastics will decrease film usage, single use plastic items ultimately be replaced with another if societal norms do not move away from reliance for convenience purposes. We must take the reliance away from single use products entirely. Throw away culture and the need for newer, better, bigger needs to collectively shift towards sufficiency. Progressive change throughout the entire plastics life cycle is required for sustainable strategies, and this concept is relevant with any single use item.

Additional questions for future research should look to address gaps in knowledge that still exist such as the role of key value chains in the plastic life cycle. This will require coordinated action amongst industry and full transparency from both businesses and government. Further studies looking into fossil fuel reliance and the impacts of such to increasing plastic consumption will be beneficial to addressing what may propel plastic reliance. In the same way that bans in previous years have come into effect (i.e. no smoking in enclosed areas), advocacy is not a movement accomplished from the top down. More public knowledge on the problematic nature of plastic film production, consumption and disposal can raise awareness that in turn may spark progressive action. While it is up to governments to listen to public needs, without citizen voice and action, there will be nothing pushing legislation to recognize the issue.

REFERENCES

- Aldag, J. (2019). *The Last Straw: Turning the tide on Plastic Pollution in Canada*. House of Commons Canada.
- Andrady, A. L., & Neal, M. A. (2009). Applications and societal benefits of plastics. *Philosophical Transactions of The Royal Society B*, 1977-1984. doi:10.1098/rstb.2008.0304
- Bamberg, S. (2013). Changing environmentally harmful behaviors: A stage model of self-regulated behavioral change. *Journal of Environmental Psychology*, 151-159. doi:https://doi.org/10.1016/j.jenvp.2013.01.002
- Behuria, P. (2021). *Ban the (plastic) bag? Explaining variation in the implementation of plastic bag bans in Rwanda, Kenya and Uganda*. doi:https://doi-org.proxy.lib.uwaterloo.ca/10.1177/2399654421994836
- Bucknall, D. (2020). Plastics as a materials system in a circular economy. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*. doi:http://dx.doi.org/10.1098/rsta.2019.0268
- Canada Energy Regulator. (2020). *Canada's Energy Future 2020*. Government of Canada.
- CCME. (2018). *Strategy on Zero Plastic Waste*.
- CCME. (2019). *Canada-wide Action Plan on Zero Plastic Waste Phase 1*.
- CCME. (2020). *Canada-wide action plan on zero plastic waste: phase 2*.
- CIEL. (2019). *Plastic & Climate: The Hidden Costs of a Plastic Planet*.
- Climate-KIC. (2018). *Municipality-led circular economy case studies*.
- Corkal, V., Levin, J., & Gass, P. (2020). *Canada's Fossil Fuel Subsidies: An Update*. Global Subsidies Initiative.
- City of Hamilton. (2012). *City of Hamilton Solid Waste Management Master Plan Review*.
- City of London. (2014). *A Waste Recycling Strategy for the City of London*.
- City of Toronto. (2021, May 17). *Waste Strategy Programs & Initiatives*. City of Toronto. <https://www.toronto.ca/services-payments/recycling-organics-garbage/long-term-waste-strategy/why-do-we-need-a-waste-strategy/>.
- Denzin, K., & Lincoln, Y. (2011). *The Sage Handbook of Qualitative Research*. Sage.
- Ellen MacArthur Foundation. (2020). *The EU's Circular Economy Action Plan*.
- Environment and Climate Change Canada. (2019). *A proposed integrated management approach to plastic products to prevent waste and pollution*. Government of Canada.
- Environment and Climate Change Canada. (2019). *Economic Study of the Canadian Plastic Industry, Market and Waste*.
- Environment and Climate Change Canada. (2020, 10 7). *Canada one-step closer to zero plastic waste by 2030*. Retrieved from Government of Canada: <https://www.canada.ca/en/environment-climate-change/news/2020/10/canada-one-step-closer-to-zero-plastic-waste-by-2030.html>

- Esmaeilian, B., Wang, B., Lewis, K., Duarte, F., Ratti, C., & Behdad, S. (2018). The future of waste management in smart and sustainable cities: A review and concept paper. *Waste Management*, 81, 177-195. doi:<https://doi.org/10.1016/j.wasman.2018.09.047>
- Essex Windsor Solid Waste Authority. (2011). *Essex Windsor Solid Waste Authority 2011 Solid Waste Management Master Plan Review and Update*.
- Essex Windsor Solid Waste Authority. (2019). *Essex Windsor Residential Waste Diversion*.
- European Commission. (2018). (rep.). *A European Strategy for Plastics in a Circular Economy*.
- Eurostat. (2021). *Monitoring Framework*. Monitoring framework - Circular economy - Eurostat. <https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework>.
- Galletta, A., & Cross, W. E. (2013). Mastering the Semi-Structured Interview and Beyond. <https://doi.org/10.18574/nyu/9780814732939.001.0001>
- Gardiner, B. (2019, 12 19). *The Plastics Pipeline: A surge of New Production is on the way*. Retrieved from Yale Environment 360: <https://e360.yale.edu/features/the-plastics-pipeline-a-surge-of-new-production-is-on-the-way>
- Geissdoerfer, M., Savagat, P., Bocken, N., & Jan Hultink, E. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*, 143, 757-768. doi:<https://doi.org/10.1016/j.jclepro.2016.12.048>
- Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science Advances*, 3(7). <https://doi.org/10.1126/sciadv.1700782>
- Giroux, L. (2014). (rep.). *State of Waste Management in Canada*. Canadian Council of Ministers of Environment.
- Government of Alberta. (2021, 02 25). *Alberta Major Projects*. Retrieved from Alberta: https://majorprojects.alberta.ca/#/?sector=Oil-and-Gas&type=Oil-and-Gas_Distribution/Storage,Oil-and-Gas_Gas,Oil-and-Gas_Oil-Sands:-In-Situ,Oil-and-Gas_Oil-Sands:-Mining,Oil-and-Gas_Other,Oil-and-Gas_Upgrader&includeNoEstimates=1
- Government of Canada. (2017, 01 04). *Archived- Industry Profile for the Canadian plastic products industry*. Retrieved from Government of Canada: <https://www.ic.gc.ca/eic/site/plastics-plastiques.nsf/eng/pl01383.html>
- Government of Canada. (2019, 06 10). *Canada to ban harmful single-use plastics and hold companies responsible for plastic waste*. Retrieved from Prime Minister of Canada Justin Trudeau: <https://pm.gc.ca/en/news/news-releases/2019/06/10/canada-ban-harmful-single-use-plastics-and-hold-companies-responsible>
- Government of Canada, Statistics Canada. (2020, 07 09). Disposal of waste, by source. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810003201>.
- Government of Canada. (2020, 10 06). *Energy and the Economy*. Retrieved from Government of Canada: <https://www.nrcan.gc.ca/science-data/data-analysis/energy-data-analysis/energy-facts/energy-and-economy/20062>
- Government of Canada. (2020, 04 27). *Ocean's Plastics Charter*. Retrieved from Government of Canada: <https://www.canada.ca/en/environment-climate-change/corporate/international-affairs/partnerships-organizations/ocean-plastics-charter.html>

- Government of Canada. (2020, 02 12). *Zero plastic waste: Canada's actions*. Retrieved from Government of Canada: <https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/zero-plastic-waste/canada-action.html>
- Government of Canada. (2021, 02 05). *Government of Canada*. Retrieved from Zero Plastic Waste Initiative: <https://www.canada.ca/en/environment-climate-change/services/environmental-funding/programs/zero-plastic-waste-initiative.html>
- Government of Ontario. (2016, 06 09). *Waste-Free Ontario Act*. Retrieved from Ontario's Regulatory Registry: <https://www.ontariocanada.com/registry/view.do?postingId=19982#:~:text=The%20Resource%20Recovery%20and%20Circular%20Economy%20Act%2C%202016%20will%20implement,resources%20and%20reducing%20associated%20waste>
- Government of Ontario. (2020). *Resource Recovery and Circular Economy Act, 2016, S.O. 2016, c. 12, Sched. 1*. Retrieved from <https://www.ontario.ca/laws/statute/16r12>
- Hopewell, J., Dvorak, R., & Kosior, E. (2009). Plastics recycling: challenges and opportunities. *Philosophical Transactions B*, 2115-2126. doi:10.1098/rstb.2008.0311
- Jakovcevic, A., Steg, L., Mazzeo, N., Caballero, R., Franco, P., Putrino, N., & Favara, J. (2014). Charges for plastic bags: Motivational and behavioral effects. *Journal of Environmental Psychology*, 40, 372-380. doi:10.1016/j.jenvp.2014.09.004
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768–771. <https://doi.org/10.1126/science.1260352>
- Johnston, J. (2019, April 9). *Why B.C. is better at recycling than most other places | CBC News*. CBCnews. <https://www.cbc.ca/news/canada/british-columbia/b-c-recycling-explainer-1.5089661>.
- Katz, C. (2019, 03 07). *Piling up: How China's Ban on Importing Waste has Stalled Global Recycling*. Retrieved from Yale Environment 360: <https://e360.yale.edu/features/piling-up-how-chinas-ban-on-importing-waste-has-stalled-global-recycling>
- Liverant, B. (2018). *Buying Happiness: The Emergence of Consumer Consciousness in English Canada*. UBC Press.
- Lindhqvist, T. (2000). *Extended Producer Responsibility in Cleaner Production Policy Principle to Promote Environmental Improvements of Product Systems*. IIIIEE, Lund University.
- Lindhqvist, T., & Lidgren, K. (1990). (rep.). "Modeller för förlängt producentansvar" ("Models for Extended Producer Responsibility," in Swedish). Ministry of the Environment in "Från vaggan till gravén — sex studier av varors miljöpåverkan" ("From the Cradle to the Grave — six studies of the environmental impact of products," in Swedish).
- McKenna, C. (2019, 06 10). Bloomberg Markets Canada's single use plastic ban could result in jobs gains: Environment minister. (B. Bloomberg, Interviewer) Canada.
- More Recycling. (2018). (rep.). *2016 National Post-Consumer Plastic Bag & Film Recycling Report*. American Chemistry Council. Retrieved from <https://plastics.americanchemistry.com/2016-National-Post-Consumer-Plastic-Bag-and-Film-Recycling-Report.pdf>
- Niagara Region. (2013). *Blue Box Ins and Outs Niagara Region*.

- Niagara Region. (2016). *2015/2016 Seasonal Low-Density Residential Dwelling Curbside Waste Composition Study*.
- Nielsen, T. D., Holmberg, K., & Stripple, J. (2019). Need a bag? A review of public policies on plastic carrier bags- Where, how and to what effect? *Waste Management*, 428-440. doi:<https://doi.org/10.1016/j.wasman.2019.02.025>
- Ocean Conservancy. (2017). (rep.). *International Coastal Cleanup Report 2017*. Ocean Conservancy. Retrieved from https://oceanconservancy.org/wp-content/uploads/2017/06/International-Coastal-Cleanup_2017-Report.pdf
- Ocean Wise. (2017, 12 07). *Rwanda's Plastic-Bag Black Market*. Retrieved from Ocean Wise: <https://ocean.org/articles/rwandas-plastic-bag-black-market/>
- Parajuly, K., Fitzpatrick, C., Muldoon, O., Kuehr, R. (2020). Behavioral change for the circular economy: A review with focus on electronic waste management in the EU. *Resources, Conservation & Recycling: X*, 6. <https://doi.org/10.1016/j.rcrx.2020.100035>
- Patton, M. Q. (2015). *Qualitative Evaluation and Research Methods*. Sage.
- Reclay StewardEdge. (2013). (rep.). *Analysis of Flexible Film Plastics Packaging Diversion Systems*. Continuous Improvement Fund.
- Reclay StewardEdge. (2017). (rep.). *Regional Municipality of Waterloo, Process/Equipment Review, Material Recycling Centre (MRC)*. Holliday Recycling Technologies.
- Recycling Council of Ontario. (2021, 02 21). *How Waste is Regulated in Ontario*. Retrieved from Recycling Council of Ontario: <https://rco.on.ca/resources/how-waste-is-regulated/>
- Ritchie, H. (2018). *Plastic Pollution*. Retrieved from Our World in Data: <https://ourworldindata.org/plastic-pollution>
- Shedler, M. (2017). *A Report on the Status of Post Consumer Plastic Packaging Recycling in the USA and Canada*. LOM Enterprises.
- Shedler, M. (2018). *A Report on the Status of the Markets for Post Consumer Plastic Packaging Recycling in the USA and Canada*. LOM Enterprises.
- Sicotte, D., & Seamon, J. (2020). Solving the Plastics Prolem: Moving the U.S. from Recycling to Reduction. *Society & Natural Resources*, 34, 393-402. doi:10.1080/08941920.2020.1801922
- Sijtsema, S. J., Snoek, H. M., van Haaster-de Winter, M. A., & Dagevos, H. (2019). Let's Talk about Circular Economy: A Qualitative Exploration of Consumer Perceptions. *Sustainability*, 12(1), 286. <https://doi.org/10.3390/su12010286>
- Stahel, W. (2016). The Circular Economy. *Nature*, 531(7595), 435-438. doi:10.1038/531435a
- Stewardship Ontario. (2021). *Draft Blue Box Program Plan Now Available for Stakeholder Review and Comment*. Retrieved from Stewardship Ontario: <https://stewardshipontario.ca/draft-a-bbpb/>
- Sutton, J. (2009, 12 15). *Why is it cheaper to make new plastic bottles than to recycle old ones?* Retrieved from MIT: School of Engineering: <https://engineering.mit.edu/engage/ask-an-engineer/why-is-it-cheaper-to-make-new-plastic-bottles-than-to-recycle-old-ones/>

- The Canadian Press. (2020, 01 31). *Fort Saskatchewan ethylene plant to increase capacity in US\$200M expansion*. Retrieved from CTV News: <https://edmonton.ctvnews.ca/fort-saskatchewan-ethylene-plant-to-increase-capacity-in-us-200m-expansion-1.4792606>
- Tomić, T., & Schneider, D. R. (2018). The role of energy from waste in circular economy and closing the loop concept – Energy analysis approach. *Renewable & Sustainable Energy Reviews*, 98, 268–287. <https://doi.org/10.1016/j.rser.2018.09.029>
- UN Environment. (2018). (rep.). *UN Environment 2018 Annual Report*. Retrieved from <https://www.unep.org/resources/un-environment-2018-annual-report>
- Whyte, C. R., Irakoze, G., Katanisa, P., Desmond, P. et al. (2020) *Circular economy in the Africa-EU cooperation- Country Report for Rwanda*. Country report under EC Contract ENV.F.2./ETU/2018/004 Project: "Circular Economy in Africa-EU cooperation", Trinomics B.V. ACEN, adelphi Consult GmbH and Cambridge Econometrics Ltd.
- World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company. (2016). *The New Plastics Economy: Rethinking the Future of Plastics*. Retrieved from <http://www.ellenmacarthurfoundation.org/publications>

APPENDICES

APPENDIX A- INFORMATION LETTER

Title of the Study: Plastic Packaging and Film Waste Management in SWO

Faculty Supervisor: Dr. Stephen Murphy, Bsc, PhD, School of Environment, Resources and Sustainability, University of Waterloo. Phone: 519-888-4567, ext. 35616, Email: sd2murph@uwaterloo.ca

Student Investigator: Amanda Lim, MES Candidate, School of Environment, Resources and Sustainability, University of Waterloo. Email: ayylim@uwaterloo.ca

To help you make an informed decision regarding your participation, this letter will explain what the study is about, any possible risks and benefits, and your rights as a research participant. If you do not understand something in the letter, please contact the student investigator prior to consenting to the study.

Invitation to Participation

You are invited to participate in a research study about plastic packaging and film waste management in South Western Ontario. The purpose of the study is to analyze current popular waste management strategies for use in a viable implementation plan appropriate for a Canadian landscape, specifically Southern Ontario. This study is a student level research project necessary for the completion of a thesis, as required for a Masters of Environmental Science designation.

Study Objectives

This study aims to fill in the knowledge gaps that exist within current plastic waste management strategies in a Canadian landscape. Specifically, to address multidisciplinary approaches including legislative, social and economic factors, in addition to identifying any barriers to implementation in current strategies.

The production of plastics has drastically increased through the years, leading to plastic film and packaging litter becoming ubiquitous in our surroundings. The remnants of plastic waste can often be found in unintended places such as in our oceans, in the stomachs of animals and even in our food. Although plastic packaging has considerable economic benefits to businesses due to their lightweight nature, durability and persistence, these same characteristics harm ecosystem services and species right from their production to disposal.

In order to decrease their environmental impacts, sustainable initiatives such as encouraging a circular economy (CE) model focusing on continual reuse and reduction of raw materials used in production, will have to be considered moving forward. A successful circular economy relies on the cooperation of multiple stakeholders such as businesses, citizens, and the government.

Multiple studies have been done on the negative impact of single use plastic packaging and film on ecosystems and the environment, while only solely considering the economy or technology in strategies presented. However, no studies have acknowledged the economic, social and legislative influences on successful plastic packaging and film waste management collectively.

I. Your responsibilities as a participant

What does participation involve?

Participation in this study will involve a semi-structured interview that will take approximately 60-75 minutes of your time. Semi-structured interviews will be conducted consisting of anywhere between 7-10 questions. Interviews can be conducted in person or via telephone/online video chat according to your preference. Any additional information outside of interview questions can be noted at your request. Sessions will be scheduled at least 2 weeks in advance to accommodate to your schedule, and in person interviews will be conducted at your site of choice (i.e. University of Waterloo or at your place of employment, etc.). With your permission, the interview will be audio-recorded to facilitate the collection of information and later transcribed for analysis. Types of questions that will be asked will vary according to sample groups sorted according to designations, but will include questions like; What is the impact of your industry on plastic film waste management? Why do you think that our society has become so reliant on

plastic film products and do you believe that they are necessary for the functionality of our Canadian society?

Who may participate in the study?

This study will involve individuals tied to plastic waste management industries that include but are not limited to: businesses, municipal/private landfills as well as processing plants (materials recovery facilities).

II. Your rights as a participant

Is participation voluntary?

Your participation in this study is voluntary. You may decline to answer any question(s) you prefer not to answer by requesting to skip the question and you may decide to end the interview at any time by communicating this to the researcher. You can request your data be removed from the study up until June 2020, as it is not possible to withdraw your data once my thesis has been submitted.

What are the possible benefits of the study?

Participation in this study may not provide any personal benefit to you. However, information that has been collected as a whole will be able to help shed light on plastic waste management issues in Canada and contribute further knowledge to improve or encourage sustainable business practices.

What are the risks associated with the study?

There are no known or anticipated risks associated with participation in the study. If a question makes you uncomfortable, you can choose not to answer. See above for more details on voluntary participation.

III. Privacy and Data Retention

If you do not wish to be identified, your participation will be considered confidential by default. Identifying information will be removed from the data that is collected and your name will not appear in any presentation or publication resulting from this study; however, with your permission, quotations may be used and you will be referenced only generally by your role (e.g. Sustainability Analyst). Alternatively, you may decide to be identified by name and have your contributions directly attributed to you in study results. Collected data will be securely stored for a minimum of one year on a password protected computer and in a locked office.

IV. Questions, Comments or Concerns

Has the study received ethics clearance?

The study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#41689). If you have questions for the Committee, please contact the Office of Research Ethics at 519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca

Who should I contact if I have questions regarding my participation in the study?

If you have any questions regarding this study, or would like additional information to assist you in reaching a decision about participation, please contact Amanda Lim at ayylim@uwaterloo.ca or Stephen Murphy at sd2murph@uwaterloo.ca.

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APPENDIX B- SURVEY QUESTIONS

Each question asked will either expand our knowledge (**EK**) on specific plastics processes related to each stakeholder, or directly relate to one or more of the 5 interventions (**1-5**), and focus on either social, economic or environmental/legislative influences (**S,EC,L**) that will ultimately give us more insight on what may lead to the success/failure of each intervention.

MRFs (for those that process plastic film)- this sample population has been specifically chosen due to their direct involvement with plastic film recycling. They process plastic film and act as a middle man between the consumer and end markets. They can contribute to the increase/decrease of available secondary material. They will be interviewed to determine what economic and social influences drive their actions/impact.

1. What impact does your MRF have on the plastic film industry (i.e. percentage of all film in Canada you process, where your supply comes from, etc.)? What kinds of plastics do you process, and can you take me through the recycling process from the input of collected materials to output of recycled secondary products? (**EK**)
2. In your facility, how much plastic film do you process in comparison to other types of plastics and are you able to justify those numbers? Are there ever any high/low seasons for plastic film recycling and what factors influence the recyclability of the plastic film that you process? (**1EC, 3EC**)
3. What are the main markets that you serve and why (i.e. export markets and location, why is there a focus in these areas, what products are made with your output, etc.)? With the tightening of Chinese import regulations, it has been publicised that the plastic industry is in “crisis” mode, does this change in law effect the way your business operates? (**1EC**)
4. What technologies are available at your facility that allows your MRF to process plastic film, and do you believe that an increase in efficiency along the plastics value chain will require more/less technology in the future? (**3EC, 4EC**)
5. What recent advancements have been made in processing technologies that may allow more MRFs to take in plastic film? Do you believe that more MRFs will collect plastic film if these technologies become more accessible? (**3EC, 3S**)
6. What economic and social motivations does your MRF have for entering the plastic film market? What do you believe are the biggest drivers of the plastic film industry and what factors do you believe have to be present in order to create a national/global market for plastic film and why? (**1EC, 1S**)
7. What factors do you believe contribute to successful plastic film management and how important is each factor when considering the entire scope of plastic film processing? (**2S**)
8. Do you believe that a market for secondary film materials will exist in the next 5 years? 10 years? 15+years? Why? (**1EC**)
9. Do you believe that MRFs are able to influence and/or contribute to the creation of a circular economy? Why or why not? (**3S**)
10. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? (**2S**)

MRFs (those that do not process plastic film)

1. What impact does your MRF have on the plastic recycling industry (i.e. percentage of all film in Canada you process, where your supply comes from, etc.)? What kinds of plastics do you process, and can you take me through the recycling process from the input of collected materials to output of recycled secondary products? (**EK**)
2. Why did your plant choose to exclude processing plastic film, and what do you believe are the main barriers to successful plastic film recycling? (**1EC, 3EC**)

3. What are the main markets that you serve and why (i.e. export markets and location, why is there a focus in these areas, what products are made with your output, etc.)? With the tightening of Chinese import regulations, it has been publicised that the plastic industry is in “crisis” mode, does this change in law effect the way your business operates? **(1EC)**
4. What technologies would your facility require in order to process plastic film, and do you believe that an increase in efficiency along the plastics value chain will require more/less technology making it more/less feasible? **(3EC, 4EC)**
5. What economic and social motivations does your organization have for excluding plastic film processing? What do you believe are the biggest drivers of the plastic film industry and what factors do you believe have to be present in order to create a national/global market for plastic film and why? **(1EC, 1S)**
6. Do you believe that this market for secondary film materials will exist in the next 5 years? 10 years? 15+years? Why? **(1EC)**
7. What advancements have been made in processing technologies that may allow more MRFS to take in plastic film? Will your facility likely collect plastic film if these technologies become more accessible? **(3EC, 3S)**
8. What factors do you believe contribute to successful plastic management and how important is each factor when considering the entire scope of plastics processing **(2S)**
9. Do you believe that MRFs are able to influence and/or contribute to the creation of a circular economy? Why or why not? **(3S)**
10. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? **(2S)**

IC&I (Ontario Cannabis Stores, Meat/Produce Distributors, Pharmaceutical Manufacturers)- this sample population has been specifically chosen due to their influence on the amount of plastic film available. Since their business processes require the use of plastic film in packaging, whether through legislative requirements or for best practices, these sectors directly contribute to the amount of plastic film produced and used by end consumers. They will be interviewed to determine what economic, social and legislative influences drive their actions/impacts.

1. What kind of industry do you operate within, and what federal/professional guidelines do you adhere by, if any? **(EK,4S, 4L)**
2. How stringent are the packaging requirements within your sector and can you share what you use plastic film for in your products? **(EK, 2L)**
3. What makes plastic film the optimal choice for packaging your goods and is it essential to guaranteeing the safety/effectiveness of your product? **(4EC, 4L)**
4. Do you believe that there are other alternatives that can be used besides plastic film to package your goods and can you elaborate on why there are/aren't? **(4EC, 5EC, 4L, 5L)**
5. Do you believe that there is a way that you are able to reduce plastic film packaging in your products and overall reduce waste downstream? If yes/no, please elaborate on why. **(2S, 2EC, 4EC, 4L, 5EC, 5L)**
6. Are there currently any take back programs that you participate in to reduce packaging waste, if so, can you explain the process to me? If not, would you be interested in participating in these programs? Why/why not and can you share what programs/ideas you would be interested in participating in, whether they are your own or current initiatives implemented within your industry? **(2S, 3S, 4S)**
7. What influences, if any, do you believe that your organization has on creating a circular economy? **(2S, 5S)**
8. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? Feel free to relate the use of plastic film in your products to your answer. **(2S)**

Agriculture- this sample population has been specifically chosen due to the large amounts of plastic film used within the industry. Plastic film management within the industry has been developed, however, these have all been out of province and Ontario options are rather limited. This population will be interviewed to determine what the barriers to Ontario implementation are and identify why the province might lack or be reluctant to implementing a plastic film management plan now.

1. What is the purpose of plastic film within the agricultural industry and is it a legislative requirement or more for best practices or convenience purposes? **(EK)**
2. Are you able to identify any feasible alternatives to plastic film? Why/why not? **(4EC, 4S)**
3. Why do you believe that there is currently no plastic film waste management strategy in the agricultural industry within Ontario, but there is a presence in Western Canada? Please identify any economic, social, legislative or environmental factors that may be relevant. **(2S, 2L, 3EC, 3S, 4EC, 4S)**
4. Do you believe that farmers would be more receptive to higher costs with less environmental impact, or do you believe that economics have a large influence on self-motivated choices of farmers? Why/why not? **(4EC, 4S)**
5. Are there any take back programs currently in development to reduce plastic film waste that you are aware of? If yes, can you please explain them to me. If no, can you share what ideas you would be interested in participating. **(2S, 3S, 4S)**
6. What influences, if any, do you believe that your organization has on creating a circular economy? **(2S, 5S)**
7. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? **(2S)**

Landfills- this sample population has been specifically chosen due to their direct involvement at the end of life cycle of plastic film. More than often, plastic film ends up in landfills and will take up the limited amount of space that we have left, litter surrounding areas by getting blown around, as well as cause operational issues within the facility. They will be interviewed to determine what social and legislative influences drive the consumption of plastic film, and what they believe can help reduce the amount of plastic film sent to landfills.

Landfills within the Province that do not have a single use plastics ban:

1. What are your thoughts on how plastic film waste is currently managed in (city here)? What do you know about plastic film usage in Canada? Ontario? (city here)? Do you think plastic film waste management can be improved with (extended producer responsibility/reduction of waste downstream/expanding recovery systems)? **(EK)**
2. How much capacity would you say that plastic products such as bottles and film take up in your landfill, and does it effect your operations in any way whether it be logistical, environmental or economical? Can you elaborate on your answer? **(EK, 3EC, 3S, 4EC, 4S)**
3. Why do you believe that most plastic film end up at landfills, rather than being successfully recycled and have you noticed an influx of materials after the Chinese import ban on plastics? What are the short term and long-term effects of excessive plastic film waste on the landfill? **(2S, 3EC, 3L, 4EC, 4L)**
4. Are there currently any public initiatives being run that help encourage waste diversion and can you elaborate on what they are? If not, do you see any initiatives being implemented soon? Why or why not? **(2S, 2EC, 2L)**
5. The harmful effects of using single use plastics is a popular topic discussed in media today. What do you believe are the largest barriers to successful waste diversion and do you feel like we are able to overcome them for a zero-waste future? **(2S, 4S)**
6. What influence (social, economic, legislative) plays the largest role within your municipality in encouraging waste diversion? Do you believe that it is possible to completely divert all plastic film products from landfills in the next 5 years? 10 years? 15+ years? Why? **(1EC, 2S, 5S)**

7. Please describe your interpretation of the optimal plastic film waste management strategy, whether the focus is on diversion, no future production of plastic film, etc. **(EK)**
8. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? **(2S)**
9. What influences, if any, do you believe that any landfill has on creating a circular economy within the municipality in which they operate in? What influences, if any, do you believe that your landfill has on creating a circular economy within the municipality? **(2S, 5S)**

Landfills out of Province that have a single use plastics ban:

1. What are your thoughts on how plastic film waste is currently managed in (city here)? What do you know about plastic film usage in Canada? British Columbia? (city here)? Do you think plastic film waste management can be improved with (extended producer responsibility/reduction of waste downstream/expanding recovery systems)? **(EK)**
2. How much capacity would you say that plastic products such as bottles and film take up in your landfill, and does it effect your operations in any way whether it be logistical, environmental or economical? Can you elaborate on your answer? **(EK, 3EC, 3S, 4EC, 4S)**
3. Why do you believe that most plastic film end up at landfills, rather than being successfully recycled and have you noticed an influx of materials after the Chinese import ban on plastics? What are the short term and long-term effects of excessive plastic film waste on the landfill? **(2S, 3EC, 3L, 4EC, 4L)**
4. Are there currently any public initiatives being run that help encourage waste diversion and can you elaborate on what they are? If not, do you see any initiatives being implemented soon? Why or why not? **(2S, 2EC, 2L)**
5. The harmful effects of using single use plastics is a popular topic discussed in media today. What do you believe are the largest barriers to successful waste diversion and do you feel like we are able to overcome them for a zero-waste future? **(2S, 4S)**
6. What influence (social, economic, legislative) plays the largest role within your municipality in encouraging waste diversion? Do you believe that it is possible to completely divert all plastic film products from landfills in the next 5 years? 10 years? 15+ years? Why? **(1EC, 2S, 5S)**
7. Please describe your interpretation of the optimal plastic film waste management strategy, whether the focus is on diversion, no future production of plastic film, etc. **(EK)**
8. Why do you think that our society has become so reliant on plastic film products, and do you believe that they are necessary for the functionality of our Canadian society? **(2S)**
9. What influences, if any, do you believe that any landfill has on creating a circular economy within the municipality in which they operate in? What influences, if any, do you believe that your landfill has on creating a circular economy within the municipality? **(2S, 5S)**

I understand that most participants will only be able to dedicate about an hour of their time to answer my questions. For this reason, I have identified questions that I am likely able to gather from secondary sources in red above, in the event that I run out of time.