FINAL OUTCOMES REPORT (NON-CONFIDENTIAL)

1.0 PROJECT INFORMATION

1. ERA PROJECT ID #	CE0162062
2. CALL / ROUND	Circular Economy Grant
3. PROJECT TITLE	HDPE Recycling Project
4. COMPANY NAME	RBW Waste Management Ltd.
5. PROJECT TYPE (R&D, Development, Demonstration, Implementation)	Implementation
6. LOCATION (primary location the project took place by address, land description, or GPS coordinates)	3907 69th Ave, Edmonton, AB, T6B 3G4
7. PROJECT START DATE	April 6, 2023
8. PROJECT COMPLETION DATE	Dec 31, 2024
9. TECHNOLOGY READINESS LEVEL (TRL) AT PROJECT INITIATION	8
10. TRL AT PROJECT COMPLETION	9
11. JOBS CREATED	3
12. GHG EMISSIONS REDUCED (Project-level: annual, cumulatively by 2030 and by 2050)	Annual: 292 tCO_2e 2030: 2,036 tCO_2e 2050: 25,955 tCO_2e
13. TOTAL ERA FUNDING	$663,400

14. TOTAL PROJECT VALUE	$1,465,376.79
15. ERA PROJECT ADVISOR	Mehr Nikoo
16. SUBMISSION DATE	March 28, 2025
17. KEY PROJECT CONTACT NAME AND EMAIL	Yvana Moldenhauer Yvana.moldenhauer@rbwgroup.com
18. QUOTE	ERA funding was essential to show that creating a circular economy with plastic waste is achievable. This project reduced GHG production while producing a commercially viable product, showcasing that circular designs are possible, and can be used to increase Alberta's environmental, social and economic sustainability.
19. NOTABLE COMMUNICATIONS	https://www.canplastics.com/canplastics/alberta-recycler-gets-funding-for-novel-hdpe-recycling-system/1003461060/ https://resource-recycling.com/plastics/2023/02/28/hazmat-specialist-builds-out-plastics-recycling-system/

20. IMAGE	RECYCLE RBW collects waste plastic SORT Sorted into types and colour streams SHRED Shredded to reduce the size WASH Washed to remove contaminants GRIND Ground into a granular form EXTRUDE Melted plastic is molded into shapes

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5.0 EXECUTIVE SUMMARY

RBW Waste Management Ltd. (RBW) is an Alberta-based company providing hazardous waste management services throughout western Canada. One of the waste streams RBW receives in significant quantities is contaminated high-density polyethylene (HDPE). RBW receives an average of 164 tonnes of waste HDPE annually, comprised mainly of empty jugs, pails, totes, and drums, contaminated with residue of the product they last contained. It has long been in the company's vision to develop an in-house recycling option for this material, but the required expenditure to develop and initiate a new process like this was prohibitive. The ERA Circular Economy Grant RBW received finally made it possible for that vision to be realized.

This project, from beginning to implementation, was largely female-led, from the company ownership, to the project manager, to the lead production operator. The project also provided an opportunity to hire and train younger employees, excited to work in an innovative space in which waste is turned into saleable products, and where recycling and circularity are guiding principles.

With the help of the ERA grant, and innovative ideas and solutions from existing and new employees, RBW has successfully established a recycling process that takes contaminated HDPE waste produced by Alberta's resource extraction and industrial sectors and uses plastic extrusion technology to turn it into recycled plastic products to be sold back to these same industries. This recycling process results in a significant reduction in GHG emissions compared to similar products made from virgin plastic feedstock. Throughout the course of the project, RBW researched, purchased, and installed conveyors, a Grinder, an Extruder, a Cooling Tank, a Mixer, a Chiller, and several product-line-specific molds. Combining these with an existing Shredder and washing machines, RBW developed a recycling line that produces several different types of molded, recycled plastic products from a feedstock that was initially received as waste: contaminated HDPE.

The products created from the waste HDPE have been selected such that they can be sold back into the industries in which the waste was originally produced, thereby creating a circular economy. This circularity has a GHG benefit by reducing the need for virgin plastic required to make these products, and by eliminating the transport required to ship this waste stream off-site to other recyclers, whose recycling operations are often out-of-province. The target market for these products is RBW's current Oil and Gas, Industrial and Mining industry customers, who are interested in full-circle recycling solutions for their waste because of environmental commitments and shareholder demands. These waste producers also need products to prevent trucks and equipment from damaging buildings, utilities, fences, or the vehicle or equipment itself, which determined one of the main products RBW has been making from the recycled plastic feedstock: curb stops.

By leveraging the different colours of plastic waste RBW already receives, it has been possible to make different colours of products without requiring the use of dyes. One of the opportunities RBW has seized is to develop blue curb stops for use in designated disabled parking stalls. Appropriately-coloured curb stop will help to make these important parking spaces easier to identify than paint on a parking surface alone and help to ensure that these spaces are left free for their intended occupancy.

RBW had an initial goal of producing 8,000 kg of molded, recycled plastic products per month. RBW met and has since surpassed that goal, currently producing ~4,000 kg of recycled plastic curb stops per week. This is equivalent to a 11.4 tCO2 GHG reduction per week. Prior to recycling this HDPE waste in-house, RBW was sorting, bulking and transporting full 53' van trailers full of this material to Lacombe, Alberta where the material was ground and shipped to eastern Canada for recycling. In 2022, RBW made the trip to Lacombe 15 times, with a total transport cost of $7,875. RBW also paid a recycling fee of $15 per bale of plastic, which represents a further cost of $6,750.

These transport and recycling fees, as well as the GHGs associated with transport to the recycler, have been eliminated by keeping the plastic and recycling it in-house in Alberta.

6.0 PROJECT DESCRIPTION

6.1 INTRODUCTION

RBW sought to develop a process to take contaminated HDPE waste and produce a valuable product that could be used by the same industries that produced the waste. Annually, RBW receives an average of 164 tonnes of plastic waste, comprised primarily of HDPE jugs, pails, totes, and drums, which are received from different industries and contaminated by different products. The HDPE recycling process was designed to recycle these incoming materials into saleable, recycled plastic products, thus establishing a circular economy using HDPE waste as a feedstock. The primary steps in the process are summarized chronologically below:

1. The first step is to sort the raw plastic material received at the facility into different HDPE categories. Pails are sorted by contamination type and colour, and any metal handles are removed. Jugs and pail lids are sorted into two categories: one is contaminated with oil, and the other is all other contaminant types. Drums are sorted by colour. Tote bladders are all processed together. The sorted HDPE material is fed onto a conveyor that carries it up to the hopper of the Shredder. Once RBW has obtained enough of a shredded plastic colour or category to fill a washing machine, shredded HDPE is loaded into an industrial washing machine to remove contamination. Clean material is collected in a bag that can be easily moved with a forklift.

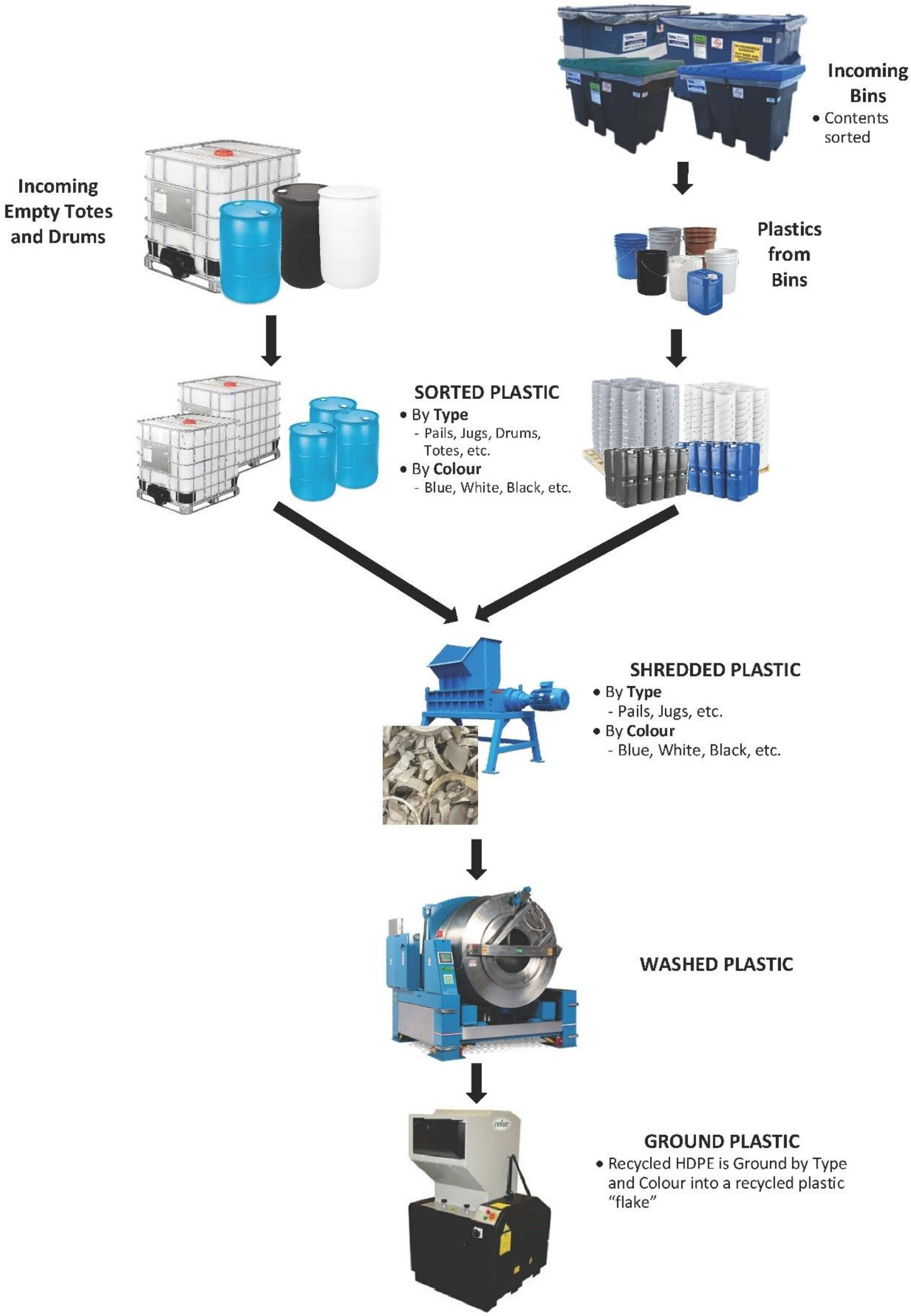
Figure 1: Typical RBW Plastic Waste (From Left IBC Tote Bladders, Pails, and Jugs and Lids)

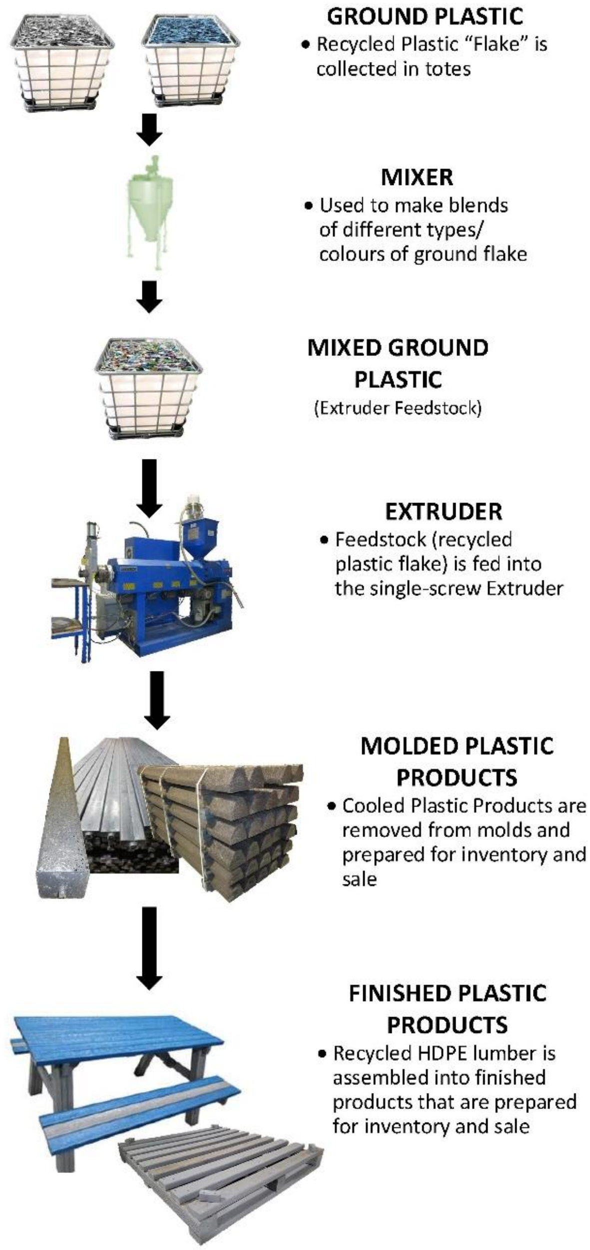
2. Clean, shredded materials are moved from the Processing Building to the Plastics Building on-site via forklift. Once in the Plastics Building, they are allowed to dry. Once dry, they are loaded onto a conveyor that feeds into the Grinder. Ground material is collected in open-top tote bladders (which are re-used waste plastic) before being labelled, weighed and scanned into our electronic tracking system. The totes of ground plastic are stored in RBW's new plastic storage Quonset.
3. Ground material of various types and colours is loaded into a Mixer according to a determined formula that results in a desired colour or finish of product. The material is then sucked up via vacuum into the hopper feed for the Extruder from which it is slowly introduced into the Extruder. The Extruder compresses, melts, and extrudes the material to fill the attached mold. Employees manually move the mold with the assistance of a crane into a cooling tank, where it is cooled with the help of a closed-loop

piping system connected to a Chiller. The Chiller helps to ensure consistent water temperature in the cooling tank to optimize both cooling time and the quality of the finished product in the mold.

4. Cooled molds are removed from the cooling tank and a hydraulic extractor is used to push the plastic product out of the mold. The product is then stacked to further cool into a desired shape. Once fully cool, raw plastic lumber is moved to a finishing table where ends are cut off to make 4” x 4” x 12’ or 2” x 4” x 12’ HDPE boards. Raw curb stops are finished by cutting off the ends and drilling holes that allow the finished product to be secured to a floor or parking lot. Further finishing is required to produce products such as picnic tables or custom pallets from the boards. All products are then branded with the RBW logo and “100% RECYCLED”.

Figure 2: RBW Plastic Recycling Process





6.2 BACKGROUND OF THE PROJECT

While the recycling of plastics has been available as a technical solution since its invention, less than 10% of plastic in Canada is recycled [1]. Approximately 75% of this plastic is from residential sources [2]. ICI sectors have challenges as curbside waste and recycling options are not as accessible or affordable as residential programs. RBW already provides recycling and waste options to the ICI sectors and is a preferred vendor because RBW waste collection programs do not require the waste generator to sort their waste and recyclables. With over 30 years of experience developing and implementing processes for sorting waste and recyclables, RBW is ideally suited to offering recycling options for specific waste streams, such as HDPE, rather than simply disposing of unsorted, mixed wastes in a landfill.

RBW is a well-established and competitive vendor in the hazardous waste management industry in western Canada and has been processing waste and recyclables from the Oil and Gas, Mining, Industrial, and Commercial sectors since 1992. RBW's 2,500 m^2 hazardous waste recycling Plant is centrally located in Edmonton. The company's primary business model involves delivering empty mixed waste containers to customers' sites throughout Western Canada to be filled with contaminated waste. Full containers are picked up and received at the RBW Waste Management Plant. Waste from the incoming containers is sorted into various streams or types, much of which is sent off-site for further recycling. This included the 164 tonnes of waste HDPE RBW receives annually. Recycling plastic material, in particular, requires costly equipment, and extensive labour to research and develop marketable recycled plastic products. It was not financially feasible for RBW to develop an in-house Plastics Recycling process without assistance through this ERA Circular Economy grant.

The RBW HDPE Recycling Project described above is unique and innovative in that the complete recycling process is contained within one facility and thus creates a direct path for waste materials to return to their point of origin as recycled plastic products. By converting customer-generated waste plastics into feedstock used to create products which are sold back to the same customers, this circular process provides a concrete example of the sustainable systems necessary to reduce and ultimately eliminate solid wastes. This addresses a fundamental need to deal with the excess of solid waste produced in Alberta that is disposed of untreated and provides a model for future circular projects.

RBW partnered with Interlock Energy to execute this project. Interlock provided the engineering and some of the research required to determine the capital equipment needs. Interlock also determined the GHG impact of the project. RBW provided the waste HDPE, capital, facility, and manpower to execute the project.

6.3 PROJECT OBJECTIVES

- **Objective 1**: Internally process the majority of HDPE material received by RBW as a waste material from existing customers.
- **Objective 2:** Convert recycled HDPE into saleable products and sell back to existing customers thus closing the loop on waste.

These objectives were achieved. No evolution or revision were required for either. Since this project started, 77% of the HDPE received at RBW's Plant has been recycled at RBW and made into products. The remaining 23% has been sent off-site for recycling. Existing customers have purchased products made from this process.

6.4 PERFORMANCE/SUCCESS METRICS IDENTIFIED IN THE CONTRIBUTION AGREEMENT

Table 1: Updated Technology Success Metrics

Success Metric	Project Target	Project Achievement	Explanation
Percent of plastic shipped off-site for recycling	10%	22.6%	RBW started recycling 100% of HDPE. Early on in the project it was determined that HDPE used in making totes and drums cannot be used on their own for extrusion. They can only be used in a blend, at a maximum of 10% by volume. Further increasing the

			amount of HDPE from tote bladders or drums in the Extruder feedstock causes the material not to extrude properly, take too long to cool and has negative impacts on resulting product quality. Therefore, most IBC tote bladders are being sent off site for reuse rather than being recycled. (see section 7.3 for more information regarding the reasoning for reuse some specific HDPE material off-site)
Weight of Recycled Plastic Products Produced	8 tonnes/ month	16 tonnes/ month (16,185 kg)	This is an average taken from the January, February and March 2025 finished product log. If the volume of incoming plastic waste is not a limiting factor, RBW is able to produce an average of 4,073 kg of curb stops per week and 27 high-profile curb stops per day
Created additional full-time position	1	3	3 new positions were created through the course of this project, resulting in 3 new hires: • Position 1: grinds plastic, weighs plastic, makes ground mixes, and builds complex finished products such as pallets or picnic tables • Position 2: extrudes plastic, tracks cooling times, removes products from molds and stacks for optimal cooling • Position 3: takes cooled plastics and finishes product by cutting ends, drilling holes, branding, making pallets for storage and barcoding the pallets of finished product before they are moved into inventory
Sales of recycled plastic products to distribution company	5 tonnes/ month	1 tonne/ month curb stops sold to customers 3.8 tonnes/ month battery tray pallets used internally by RBW to be used on	RBW decided to focus on products that have sales that will not be consistent month to month. We currently have enough curb stops to be able to sell in large quantities this spring. Curb stops are generally installed between May and October when parking lots are free from snow. They may be replacing existing, damaged curb stops, or as new installations in new parking lots. Sales of these products did not begin until November 2024. The project team is eagerly anticipating the upcoming spring/summer construction season to realize the potential for bulk sales of these products.

		customer sites	RBW has created battery tray pallets to be used on customer sites and during transportation. These custom-designed pallets offer significant safety advantages over historically-used wooden pallets. The recycled plastic pallets are the correct size, stack securely, and support the weight of containers filled with large industrial waste batteries without breaking.

RBW is a company that is well-suited to react to challenges and shift strategic direction as required. Between the end of November and December 2024, RBW's Extruder was unexpectedly put out of service, in need of a new motor. The employees assigned to the plastic grinding and extrusion line quickly switched their focus to making picnic tables and pallets out of recycled plastic lumber that was already in inventory. Sixty-five battery tray pallets were delivered, accompanying battery trays, to sites belonging to a particular client that produces a significant amount of battery waste. All these battery trays (including their custom-made recycled plastic pallets) have since returned to RBW and been sent out again. The recycled plastic battery tray pallets RBW has built replace wood pallets that were not able to hold the weight of industrial batteries. The wood pallets presented a safety hazard during transport and handling. Rather than purchasing heavy duty plastic pallets from another vendor, RBW saw an opportunity to develop an even-better solution with a completely customized recycled plastic pallet designed in-house.

6.5 PROJECT CHANGES

RBW had initially anticipated making chock blocks as part of the Plastic Recycling project but quickly determined that this product could not easily be made with the HDPE feedstock resulting from RBW's incoming plastic waste. Unlike curb stops, chock block sales would not have been weather-dependant, and the chock block was a product that RBW's largest customer had expressed great interest in purchasing in significant quantities. While removing chock blocks from the product line was disappointing, learning and understanding the properties of our feedstock led to the opportunity to make curb stops, which we anticipate being able to sell in bulk on an ongoing basis to numerous clients.

Since the commencement of this project, RBW's president Rick Williams, stepped down and Daniel Franke now fills this role. This change has not affected the project.

6.6 TECHNOLOGY RISKS

Working with recycled plastic with non-uniform characteristics introduces the risk of not having a homogeneous resin to work with, and consequently, having batch variance in the resulting product. While the project team decided to work exclusively with HDPE, RBW processes HDPE with different characteristics, depending on the type of source material: drums, IBC tote bladders, jugs, etc. Ignoring the differences between these different "types" of HDPE would result in process failures or extensive procedural troubleshooting. The project team mitigated the impact of the differences by establishing a rigorous sorting process in which incoming plastic is categorized based on the type of material (drums, IBC tote bladders, pails, jugs, etc.) and colour. This allows RBW later to create consistent blends of HDPE that have been developed to optimize the characteristics of the specific product being made. RBW has identified differences in physical properties such as viscosity or Melt Flow Rate (MFR) that would be relevant to manufacturing. For example, making a 2" x 4"x 12' plastic boards requires plastic to be pushed through a narrow path at a relatively high speed. For this purpose, a higher MFR was needed, which is found in the HDPE used to make pails, so the blend or mix that was used for that specific product contained a higher percentage of pail resin as a result. When the project team switched to making curb stops, the product needed to have higher resistance to impact and overall toughness, properties that increase with molecular weight (MW). Knowing that higher MW distribution is associated with lower MFR in HDPE, the project team developed a resin that would have lower MFR than that was used for the plastic boards by increasing the percentage of HDPE originating from drums and jugs.

Another risk identified from the start was the availability of certain stock material, since there is variability in the quantities and ratios of plastic raw materials of various "types" that RBW receives. In the interests of developing a process that is resilient and adaptable to variation in feedstock, the project team tested and developed different blends based on average ratios of each "type" of HDPE received at RBW's facility. Employing this strategy has allowed the project team to operate at steady state without being significantly affected by the lack of a given "type" of feedstock. Determining that the identified variability in the incoming HDPE existed, developing flexible blends, and testing to determine optimal feedstock composition presented a challenge at times because production could not be stopped to allow for dedicated testing periods. Production had to continue around the testing because RBW had only one Extruder and the quotas set through this grant did not allow for any downtime.

In terms of challenges that were not first identified as potential risks, the project team underestimated the extent of the contamination level in certain batches of waste plastic. Initially, RBW developed a washing procedure, compatible with the facility's existing wastewater treatment process, that was largely effective at adequately washing the shredded plastic material. In certain cases, however, this initial washing procedure did not adequately remove contaminated residues from the plastic. When the project team attempted to grind inadequately-washed plastic, it compromised the composition of the resulting ground resin. The procedure was consequently changed to incorporate a quality control check after the washing cycle, where if personnel determine contamination has not been sufficiently eliminated by the washing process, that load of shredded plastic is cycled again for re-washing.

7.0 PROJECT WORK COMPLETED AND OUTCOMES

7.1 METHODOLOGY

Plastic material is first sorted into piles based on type (pails, drums, jugs, etc.) and colour. These piles are then shredded and collected in containers until the necessary amount of the same type and colour of material is accumulated for it to be washed. The shredded plastic is washed using soap. After drying, the material is ground into flakes and collected in 1 m^3 containers that are weighed. Material from these containers of ground flake are further mixed according to the blend (recipe) needed to make a specific product. The extrusion profile also depends on the product RBW desires to manufacture. Typically, the extrudate has a temperature of 380°F as it is coming out of the die. For low MFR resins the project team uses shear control to ensure a smooth flow. Once the mold is filled, it is immediately placed to cool in chilled water for 15-30 minutes depending on the mold. The plastic needs to cool down to shrink and reduce any warping due to uneven temperature outside of the mold.

7.2 TECHNOLOGY DEVELOPMENT

This project successfully employed existing technology in developing a process that accomplished the goal of creating a circular economy for HDPE used in the ICI sector. The process was developed through trial and error, because, as the project team discovered, the technique ultimately employed is not well-documented or broadly applicable. Extrusion molding is a well-known process that typically uses virgin plastic feedstock, which does not offer many of the challenges presented by a feedstock that comes from waste with variable characteristics.

Extrusion molding is increasing in use as a method of recycling waste plastic, but there is a lack of published information on the how's and how-not-to's of implementing such a process. Based on the material RBW was already receiving as part of their waste management operations, the decision was made to focus entirely on recycling waste HDPE, which further limited the pool of background information and data that existed. The project team therefore relied on research and making connections within the plastic recycling industry to learn as much as possible about appropriate technology, risks and opportunities relating to recycling plastic waste.

The team's learnings ultimately led to the selection of the process that was developed, and the technology employed within it. The team determined that extrusion molding was the most economical solution for converting waste HDPE into saleable products that had a potential market in the industries that originally disposed of that HDPE as waste. RBW already had shredding and washing capabilities that were being used to process other types of waste. RBW facility personnel were also already accustomed to sorting waste into pre-determined categories. The project team was able to leverage these pre-existing strengths and technology and incorporate them into the plastic recycling process that has been developed. The major piece of technology that the facility did not already have, which was required specifically to enable plastic recycling, was determined to be an Extruder.

As the extruder required a pelletized or flake feedstock, a Grinder was also required to reduce the shredded plastic to a suitable feedstock size. To make mixes of different types and colours of HDPE, a Mixer was required. The Extruder came with a Cooling Tank and a small selection of molds. Initial start-up of the Extrusion process and increased learning about the variability within different "types" of HDPE led the project team to conclude that a Chiller was also required both to increase the efficiency of the overall process, and to improve the quality of the finished products. A Chiller was subsequently procured, a closed-loop cooling water system was built and installed, and the system was commissioned. Initial challenges maintaining a constant temperature in the Cooling Tank led the project team to install a pump to circulate the Cooling Tank water. After start-up, the success or failure of different molds, learnings about cycle times, and market research regarding different recycled plastic products, led the team to procure additional molds of various types and sizes.

To load plastic into both the Shredder and the Grinder safely and efficiently, conveyors were purchased and installed. Because the Grinder blades are easily damaged by metal, the conveyor for loading the Grinder was equipped with magnets. A crane was also purchased and installed to facilitate transfer of the molds from the Extruder into the Cooling Tank. Difficulty removing cooled plastic from the molds inspired the project team to design and build a pneumatic mold extractor that has significantly enhanced this project step. Creating finished products revealed additional opportunities for safety and efficiency improvements, and the team was able to procure manual handling equipment such as electric and manual lift tables to increase efficiency and reduce the potential for employee injury during the finishing process.

At the outset, the project team developed a basic proposal for the technology that would be required to implement the process. This technology was subsequently procured, installed, and commissioned. As operation began and the team and production operators learned more about the waste HDPE feedstock and the equipment being used to recycle it, in consultation with the employees involved in executing the process, the team determined ways to improve the process and troubleshoot challenges. Because RBW was supportive of the project and is adaptable in its nature as a company, the team was able to propose process changes and procure, install, and commission additional equipment, as needed. At all points the employees involved in running the process were consulted, and their concerns, ideas, and feedback played a significant role in determining next steps and process improvements.

7.3 PROJECT ACHIEVEMENTS, RESULTS, AND ANALYSIS

The Project had two main objectives: process the majority of HDPE material received and convert rHDPE into a product that can be sold back to existing customers. In that regard, the project team was successful in establishing a robust method to receive, sort, wash and ultimately convert waste HDPE material into ground flakes of specific type and colour. That rHDPE was used to make products that could be sold back to RBW's existing customers. The project team first made plastic lumber, as originally proposed, and is able to use the lumber to make more elaborate products such as plastic pallets and picnic tables. RBW is currently using recycled plastic pallets at some of its customers' sites, with a deposit fee included in their use. Picnic tables are on pending delivery (weather permitting) to existing customers and open for custom orders. RBW is also producing plastic curb stops, a tougher alternative to rubber curb stops, without the disadvantage of concrete curb stops that crack with expansion/contraction season cycles. RBW has sold smaller orders of recycled plastic curb stops to six different customers and larger orders will be fulfilled as the spring/summer season arrives and new parking lots are paved, and damaged curb stops in existing lots are replaced. Curb stop installation usually occurs during the spring/summer season, once the ground has thawed. Please refer to Table 1 to review the Technology Success Metrics.

RBW has achieved the goal of processing all the waste HDPE received at facility and turning it into rHDPE, thereby succeeding in having 0% of plastic being shipped off-site for recycling at the commencement of the project. All types of plastic were collected, sorted, washed and ground to be used in extrusion. The project team discovered, however, that tote bladder material on its own could not be extruded with RBW's equipment. While looking for good alternative recycling opportunities for this material, the project team found an opportunity to have some of the IBC metal tote cages and HDPE tote bladders be reconditioned for reuse if they met certain criteria. Following the waste hierarchy principles, it is better to reuse or repurpose a plastic material than it is to recycle it. For these reasons, RBW decided to send some of the IBC tote cages and bladders to to be cleaned, reconditioned, and re-sold for their original use. This collaboration started in late August 2024, and, on average, RBW currently sends 23% of the total volume of plastic received at the facility for reuse. Before sending totes for reconditioning, RBW would separate the plastic tote bladders from the metal tote cages/frames. The plastic bladders were first cut into sheets and then shredded, washed, and ground, while the metal cages/frames were crushed and sent for scrap metal recycling. Sending IBC totes away for reuse minimizes the amount of metal cages/frames sent for scrap metal recycling, as these are reconditioned along with the tote bladders. The change in how this material has been managed throughout the implementation of this project is captured later in this report. RBW demonstrated the ability to manage and process all the HDPE plastic waste received (including IBC totes) between November 2023 and August 2024, even as the majority of totes received at the facility are now being sent off for reconditioning.

The project team also far surpassed the original production goal, almost doubling expectations from 8 tonnes to 16 tonnes per month. This production success was made possible by making the necessary adjustments to how the Extruder feedstock was prepared, and its composition, as well as by adapting to learnings and employee input along the way. Additionally, the employees working in the process became more proficient in producing ground flakes with more consistent properties, which significantly improved the development of new blend mixes. Keys to increasing production capacity were the use of a water tank cooled by a Chiller and procuring a sufficient quantity of molds to permit continuous flow of the process. Subsequent modifications to the molds, including powder coating, and the introduction into the process of the mold extractor have also increased process efficiency.

Although the project team had originally anticipated the Grinding and Extrusion process could be operated by a single employee, increased processing and production rates throughout the course of operations necessitated additional full-time positions dedicated to this project. RBW is proud to have an operations team of trained new employees engaged in plastic production.

Finally, the sales targets cannot yet be measured as the bulk of the products being produced are seasonal items with peak market opportunities during the spring and summer. Moreover, the curb stops being made are typically sold in large quantities rather than single units, so RBW has been concentrating on building up an inventory to be able to meet demand once the season for their installation begins. Of particular note, is the production of blue HDPE curb stops intended to be used to designate disabled parking stalls. Since the curb stop itself is entirely blue, rather than being painted blue, the colour will not fade or be washed off by rain or snow. As a recycled plastic product these curb stops also represent positive environmental stewardship and a commitment to using recycled products. Mechanically, plastic curb stops are more durable than both rubber and concrete alternatives. Please see the sales flyer below detailing some of these properties.

Figure 3: RBW Curb Stop Flyer


RECYCLE
RBW collects waste plastic
SORT
Sorted into types and colour streams
SHRED
Shredded to reduce the size
WASH
Washed to remove contaminants
GRIND
Ground into a granular form
EXTRUDE
Melted plastic is molded into shapes

8.0 LESSONS LEARNED

8.1 CHALLENGES

As discussed previously, one of the main challenges was to alleviate the issues presented by the heterogeneity of RBW's diverse plastic "types" to ensure consistent physical properties in the final recycled products. Another limitation was the fact that RBW was working with one Extruder and one type of plastic (HDPE). While working with HDPE exclusively was a choice based on existing feedstock opportunities and a desire to minimize the variables in an already complex project, it also introduced some common issues that highly linear polymers have while processing, such as shrinking, induced stress and heat transfer abilities. Because these were known issues, and there was literature and expertise within the industry regarding solutions, their occurrence could be diminished with the right adjustments.

The Extruder's die and horsepower presented limitations in terms of the number and type of different products able to be produced. The clamp pressure would have become significant if RBW had decided to increase the size of the products, for example. Additionally, the technique itself made cooling somewhat challenging as most of RBW's products are extruded mostly along one axis, such that one end has a different temperature profile than the other end. Changes in the resin blend and the speed of injection were used to address those issues. The project team also discovered that the use of low MFR resins in thin molds, such as the 2" x 4" board, resulted in unavoidable short shots. This was solved by developing different blends of HDPE for different mold configurations.

When RBW decided to change from making 2" x 4" boards to making curb stops, it was quickly discovered that the Chiller could not keep up with the increased temperatures produced by larger molds and higher volumes of hot HDPE being cooled in the same period of time. A new larger Chiller was required to be purchased after the original smaller Chiller became unable to maintain the desired temperature in the cooling tank.

Another situation encountered by the project team was in November 2024 when the motor for the Extruder stopped working. A new motor needed to be sourced which took close to a full month. Next RBW had to hire experienced contractors to install the motor and ensure that it was properly programmed and timed. This stopped plastic extrusion completely for six weeks. During the Extruder down-time, RBW personnel pivoted production and the employees involved in the plastic production process transitioned to building pallets and picnic tables from the recycled plastic lumber material that had been extruded and stockpiled earlier in the year.

8.2 PRACTICAL LEARNINGS

RBW operates with an Alberta Environmental Protection and Enhancement Act (EPEA) Approval as a hazardous waste and recyclables processing facility. At the outset of this Plastics Recycling project, RBW discovered through consultation with RBW's Approval Coordinator that introducing a Plastics Recycling line to the facility would require an amendment to RBW's approval. Because the line involves only non-hazardous materials, it was expected that only a notification would be required and did not anticipate the complication of a formal amendment application and approval process. Historically, approval amendments have been a very long process taking many-months-long to receive an approval, which caused concern about RBW's ability to meet the deadlines of the grant application and the Plastics Recycling project itself. Thankfully the facility's Approval Coordinator was very supportive of this project and respectful of the deadlines, streamlined the application process, and was able to finalize the required amendment within two months of the original contact from RBW requesting approval to proceed. Confirming licensing or permitting requirements with regulators prior to proposing initiating a new project would alleviate the unexpected stress of attempting to fast-track regulatory processes once deadlines are already in place.

In terms of meeting the project objectives, the immediate lessons learned were that it would be advantageous to conduct a pre-emptive market assessment for the target products to facilitate the commercialization phase. Not only does this market assessment allow RBW to limit production to desirable products, but it also facilitates regular communication with potential customers during production and assists in the identification of key properties or features customers may request later. Another lesson learned through challenges in production was not to underestimate the labour needed for specific process steps. Having increased labour available not only translates into increased productivity but also reduces safety risks related to employees being exposed to equipment hazards or repetitive tasks.

RBW also learned lessons with respect to procuring equipment for which spare parts are not available or are difficult to find. Throughout the course of the project, RBW experienced some down times, due to equipment limitations or difficulty in procuring replacement parts, that affected production. This lesson is especially relevant moving forward now that North America is entering times where the political landscape is resulting in increased costs, making it harder to connect to vendors from neighbouring countries or to arrange shipping across the border.

A final learning is that proper technological research prior to the start of the project eases up a lot of the technical issues encountered while developing and setting up a process. Thorough background work prior to project initiation would also help drive the development of more realistic project goals regarding budget, development and production.

8.3 ORGANIZATIONAL LEARNINGS

RBW's main learning through this project is that leveraging already-existing strengths, in terms of feedstock, training, personnel, and corporate flexibility and adaptability can promote the development and success of brand new processes that are beneficial both for RBW in its ability to provide recycling solutions for waste, and for the environment in terms of GHG reductions achieved through the implementation of those processes.

RBW personnel also gained experience in optimizing a novel process throughout the course of the past 18 months. This meant identifying bottlenecks or limiting factors and addressing them one at a time to, in this particular case, more than double the anticipated capacity of the process over the course of a year.

Throughout this project, many different limiting factors related to plastic recycling have been identified and addressed. When the contribution agreement for the grant was signed, RBW stopped sending plastic off-site and began to stockpile HDPE. This caused storage challenges at RBW's facility, as it took several months for a process to be developed and proposed, and technology to be researched, procured, installed, and commissioned. At this initial point, with process changes made to how plastic waste was received, sorted, and prepared for storage, RBW found that the amount of HDPE received at the facility exceeded the Processing department's ability to work through it on a daily basis. Once the new equipment for the Plastics Recycling line was installed and RBW started processing the plastic, shredding became extremely labour-intensive, and slowed down the RBW Processing floor, which is responsible for processing the majority of the incoming waste the facility receives, not just plastic. IBC tote bladders, for example, needed to be manually cut and folded before they could be shredded, and all plastic material needed to be loaded by hand or forklift into the Shredder. It was soon determined that IBC tote bladder plastic did not work well in the Extruder, and the project team began researching other recycling options for this material, ultimately leading to the reconditioning (reuse) option. The inefficiency of loading a large amount of plastic material into the Shredder by hand or forklift led the project team to procure a conveyor to decrease the labour demands associated with loading material into the Shredder. RBW made strategic shifts as challenges were encountered and came up with solutions that greatly reduced operational hurdle related to labour issues.

The next throughput restriction became the facility's shredded plastic washing capacity. Once the necessity of washing the shredded plastic material was discovered, RBW designated one washing machine to shredded plastics. It turned out this single machine could not keep up with the Processing Department's sorting and shredding. At this point RBW designated a second washing machine to washing shredded plastic material. Significant piping work was required to make these changes, as the facility's washing machines are set up in different ways to connect to the in-house Wastewater Treatment system. The changes, however, increased the facility's versatility and ability to pivot to different production demands. Once the second washing machine was online, washing capacity ceased to be a constraint in the process. After the washing capacity issue was solved, RBW could not keep up with grinding all the washed plastic, so a third employee was hired to be solely dedicated to this role and the project team built a table (out of HDPE 2" x 4" boards) to help load the Grinder conveyor. At this point RBW fully believed that the limitation of production was the capacity of the Extruder to produce enough products to keep up with the incoming plastic feedstock and started looking for alternative recycling options for less desirable HDPE.

Next, RBW started producing curb stops and struggled to extract them from the molds. Removing products from the molds was labour-intensive and carried with it a potential for employee injury. This challenge was approached by powder-coating the inside of the molds and designing and building a mold extractor to assist in removing the plastic product from the mold. Once the curb stop molds were easy to remove the cooled plastic from, the project team discovered that they could not cool the molds fast enough. To address this challenge, RBW purchased a larger Chiller. Once these limiting factors were all addressed, significantly increasing the overall capacity of the Plastic Recycling Line, the project team has discovered that RBW may not actually receive enough plastic to keep up with the current production capacity. This has led RBW to seek more sources for plastic waste, and to increase the percentage of drum and tote HDPE, that does not meet the acceptance criteria for reconditioning for various reasons, in the mixes rather than find alternative recycling options for these more challenging materials. Used on its own, tote and drum plastic has proven difficult to extrude, but it works as part of a mix/blend. Increasing the amount of material able to be extruded reduces the need to find alternate recycling options for some of the more difficult-to-extrude ground HDPE flake and will allow RBW to maximize the amount of recycled plastic products that can be made with the waste the facility receives.

Through encountering these production hurdles, the project team has discovered solutions and had to adapt to make plastic recycling efficient. These discoveries could not likely be researched. They needed to be challenges encountered for the correct solution to be found. RBW was very invested in the success of this project and therefore weekly management meetings became largely dedicated to discussing HDPE recycling and issues within the process and the team brainstormed and researched solutions that, once agreed upon and approved, were put into action immediately. Constantly checking in on the process and looking for ways to make it more efficient, effective, safe, and productive is very important in a project such as this.

8.4 HIGHLIGHTS

The project undertaken had the following highlights:

- Processing milestone: Changes in waste processing led to a quick and solid procedure to manage a great influx of plastic into readily usable resin for extrusion
- Production milestone: Established production at a commercialization stage within 7 months
- Technological milestone: Developed custom blends for different commercially available products while maximizing their physical properties

Some discoveries found along the way:

- Processing plastic in an organized way is very labour intensive. As much as plastic or other materials need to be recycled as a step in the direction of responsible environmental and resource stewardship, more effort should be made to make these materials reusable in some capacity at the point of their original design and manufacture. From an economic perspective, manufacturers do not often find the gap between using virgin resin and recycled resin big enough.
- Product design is key when working towards commercialization. Specifically, mold or part design is crucial for a successful streamlined production. Understanding the raw material properties also helps narrow down the type of products that can be made with available technology, and that will be marketable in both the short and long-term.
- Getting approvals to put up a simple Quonset within city limits is a difficult, costly and time-consuming project. Awareness of permit and inspection delays at the outset of a project would allow the creation of a more realistic project timeline. A better initial understanding of all the engineering and inspection requirements associated with constructing an engineered, prefabricated building, would have allowed for a more realistic budget.
- Cooling hot HDPE is very energy-intensive and can cause technical problems if done improperly. Extruding relatively large products as a solid unit brought some early challenges as the project team discovered through testing and experimentation the importance of including proper cooling equipment in the process.

9.0 GHG BENEFITS

9.1 PROJECT BASELINE EMISSIONS

The baseline case considers that 164 metric tonnes of HDPE are received, handled and shipped out of the RBW facility annually. The CO_2e associated with this material is calculated in the table below and since no circular economy exists around this material, the emissions may be considered in full as a baseline condition. The quantification methods are presented below in Table 2.

Table 2: Quantification for Project Baseline Emissions

Description - identify: **i) the activity that causes the emission, removal or storage,** **ii) if the cause of GHG effect is an source, sink or reservoir,** **iii) how it can be measured (units of measurement) and** **iv) type of effect - Primary effect and Secondary effects (one-time effects and upstream/downstream effect)**	**Explanation/Justification for why GHG effect should be included or excluded from calculations**	**Quantification Methodology Reference**
SOURCE 1 – Primary HDPE Production i. GHGs emitted from the Feedstock Extraction, Polymerization and pelletization, Material Production, and Transportation of Polyethylene ii. Source iii. Calculated at 3.0 kg CO2e per kg of plastic	Included because baseline plastic products to be replaced with recycled goods are made from virgin HDPE materials	This value taken as the mean GHG value provided by Long K. et al. “Uncertainty in the life cycle greenhouse gas emissions and costs of HDPE pipe alternatives”. Page 7.

produced. iv. Upstream primary effect (recurring)		
SOURCE 2 - Shipping i. GHG from ocean freight of existing supply chain of plastics 5612 miles from Shanghai to Vancouver by ship ii. Source iii. 10g CO_2 per tonne per mile = 56.12kg/tonne based on EU study iv. Report from the Commission 2020 Annual Report on CO_2 Emissions from Maritime Transport	Included because the recycled HDPE precludes the shipment of equivalent material from overseas	COMMISSION STAFF WORKING DOCUMENT - Full-length report - Accompanying the document - Report from the Commission - 2020 Annual Report on CO_2 Emissions from Maritime Transport
SOURCE 2 – Recycling Energy i. GHG electrical consumption to recycle HPDE ii. Source iii. 183.7kW-h per tonne of HPDE and approximately 200 tonnes CO_2e per GW-h of electricity. This is converted to 0.0002 tonnes CO_2e per kW-h	Included because the electrical power consumed by recycling is not currently consumed and reduced the overall benefit	ECCC grid intensity forecasts and power consumption calculations from vendors and chemical properties of HPDE

9.2 PROJECT EMISSIONS

RBW Waste Management Ltd. has implemented a high-density polyethylene (HDPE) recycling process at their Edmonton facility. The project processes HDPE waste into new commercial goods, closing the recycling loop and establishing a circular economy.

The recycling system consists of three main steps:

1. **Sorting, Shredding and Cleaning:** HDPE containers such as pails, jugs, drums, and totes are shredded before being cleaned to remove residual contamination before processing.

2. **Drying and Grinding:** The HDPE materials are left to naturally air-dry. Dry HDPE is ground into particles of uniform size (plastic flake) to facilitate extrusion.

3. **Extrusion and Molding:** The shredded HDPE is melted and formed into recycled plastic lumber and curb stops. The plastic lumber is further used to make finished products such as pallets and picnic tables.

This project reduces reliance on virgin HDPE production, significantly lowering lifecycle emissions associated with extraction, polymerization, and transportation.

The project emissions are calculated from consistent operation data from June to August 2024 and averaged over the entire year. The processed HDPE is shown below in Table 3, and when averaged over the three months equates to 8716 kg processed per month. This value equates to 104,588 kg when averaged over the entire year for 2024. This average is used to find the expected yearly output.

Table 3: HDPE Processed at Steady State

	HDPE Mass (kg)
June 2024	8000
July 2024	10157
August 2024	7990
Average Monthly HDPE Processed (kg)	8716

The emissions are based on the energy consumption of recycling equipment, and emissions associated with transportation. This quantification relies on measured machine runtime and power usage to recycle and produce HDPE products:

- Baseline HDPE Emissions: The innate emissions of virgin HDPE based on 2024 operation data is 314 tCO2e/yr. This is measured by considering 3.0 kg CO2e is released per 1.0 kg of virgin HDPE produced, which can be directly claimed as GHG reductions (before processing emissions).

- Energy consumption per tonne of recycled HDPE: The total power consumption of the grinder, extruder and chiller machines is measured based on daily operational data, seen in Table 3. The total power usage is 106,593 kWh per year. The total HDPE processed is 104.6 tonnes per year (as calculated above, based on 3 consecutive months of steady production). Total power divided by total HDPE gives 1019 kWh/tonne of HDPE produced.

Table 4 Electrical Machinery Run-Time and Power Consumption

	GRINDER	**EXTRUDER**	**CHILLER**
Standard Power (kW)	24.94	47.39	14.09
Idle Power (kW)	-	9.73	-
Idle Time (hr)	-	2.2	-
Heat-up Power (kW)	-	40.70	-
Heat-up Time (hr)	-	2.2	-
Daily Runtime (hr)	2.0	3.6	8
Daily Power Consumption (kWh/d)	49.9	281.5	112.7
Yearly Power Consumption (kWh/yr)	11,972	67,569	27,053

- Emissions from Recycling Process: The electricity used for HDPE recycling results in 15.9 tCO2e per year, based on a grid intensity of 0.0002 tCO2e per kWh.

- Emissions from Shipping: Considered to be 10 g CO2 per tonne, per mile. This equates to an emission of 5.9 tCO2e/yr for the 2024 operational data year.

- Net Emissions Reduction: Calculated based on the baseline HDPE emissions, minus the operational emissions, which equates to 292 tCO2e/yr in savings.

The net GHG emissions calculation is based on the following equation:

Equation 1. Net GHG Reductions Equation

$$\frac{\mathrm{tCO2e}}{\mathrm{yr}} = \mathrm{CO2e_{HDPE}} - \mathrm{CO2e_{ELEC}} - \mathrm{CO2e_{SHIP}}$$

Where

$\mathrm{CO2e_{HDPE}}$ = Baseline CO2 Equivalent in HDPE material to be recycled

$\mathrm{CO2e_{ELEC}}$ = Baseline CO2 Equivalent in HDPE material to be recycled

$\mathrm{CO2e_{SHIP}}$ = Baseline CO2 Equivalent in HDPE material to be recycled

$\frac{\mathrm{tCO2e}}{\mathrm{yr}}$ = Baseline CO2 Equivalent in HDPE material to be recycled

Table 5: Net Emissions Reductions

Factor	Quantification & Source	Value
Baseline HDPE Emissions	Calculated from reference report	314 tCO2e/yr
Energy Consumption per tonne of Recycled HDPE	Measured from machine runtime data	183.7 kWh/tonne HDPE
Emissions from recycling process	Calculated from machine runtime data	21.3 tCO2e/yr
Emissions from shipping	Calculated from reference report	5.9 tCO2e/yr
Net emissions reduction	**Calculated based on Equation 1**	**287 tCO2e/yr**

9.3 EMISSIONS REDUCTION IMPACT

Table 6: Emission Reduction Impact

In Alberta					
Year	**Baseline Emissions @Year (tCO2e)**	**Project Emissions @Year (tCO2e)**	**Estimated Annual Production (if applicable)**	**Unit of Production**	**Emissions Reduction @Year (tCO2e)**
2023	144	1.8	48	Tonnes HDPE	142.2
2024	288	3.5	96	Tonnes HDPE	284.5
2025	303	3.7	101	Tonnes HDPE	299.3

2026	318	3.9	106	Tonnes HDPE	314.1
2027	333	4.1	111	Tonnes HDPE	328.9
2028	351	4.3	117	Tonnes HDPE	346.7
2029	369	4.5	123	Tonnes HDPE	364.5
2030	387	4.7	129	Tonnes HDPE	382.3
2031-2040	405-630	5.0-7.7	135-210	Tonnes HDPE	400.0-622.3
2041-2050	660-975	8.1-11.9	220-325	Tonnes HDPE	651.9-963.1

The HDPE Recycling Project contributes to a low-carbon economy by significantly reducing emissions associated with virgin plastic production. If all virgin HDPE used in Alberta (estimated at 300,000 tonnes per year) were replaced with recycled HDPE, the potential emissions reduction would exceed 900,000 tCO2e annually.

This project helps facilitates a low-carbon economy and will help secure Alberta's GHG-constrained success by:

- Reduction in Industrial Carbon Footprint: The project saves 292 tCO2e per year, equivalent to removing 63 passenger vehicles from the road annually (EPA conversion factor: 4.6 tCO2e per vehicle per year).

- Energy Efficiency and Resource Optimization: The recycling process requires 183.7 kWh to produce one tonne of recycled HDPE. This is compared to 59.2 million BTUs (17,350 kWh) to produce one tonne of virgin HDPE, which represents significant energy savings.

- Encouraging Market Adoption of Sustainable Practices: If similar recycling programs were adopted across Canada, nationwide emissions savings could reach several million tCO2e annually.

- Alignment with Climate Policies: This project supports Alberta's 2030 Emissions Reduction Plan, which aims for 40-45% emissions reductions below 2005 levels by 2030.

Shown in Table 7 are the estimated GHG reduction milestones, assuming the recycling continues yearly until 2030 and 2050.

Table 7: Net GHG Reduction Milestones

Year	Estimated Net GHG Reductions (tCO2e)
2030	2,036
2050	25,955

10.0 ENVIRONMENTAL, ECONOMIC, AND SOCIAL IMPACTS

10.1 OTHER ENVIRONMENTAL IMPACTS

The HDPE Recycling Project provides immediate and future environmental benefits beyond GHG reductions. These include improvements in air quality, land use efficiency, water conservation, and waste management. These benefits are listed below:

AIR QUALITY BENEFITS

- Reduces emissions of criteria air contaminants (CACs) such as particulate matter (PM), nitrogen oxides (NOx), and sulfur oxides (SOx) by eliminating the need for virgin plastic production and minimizing transportation emissions.
- Eliminates volatile organic compound (VOC) emissions from the polymerization process associated with virgin HDPE production.

LAND USE AND WASTE MANAGEMENT

- Based on the production data from June to August 2024, the project diverts 104.6 tonnes of plastic waste per year from landfills, reducing environmental contamination and landfill space usage.

- RBW sends the remaining 30.5 tonnes per year of plastic waste for reconditioning and reuse. This reconditioning facility is less than 10 kms away from the RBW Waste Recycling Plant and results in ICB totes cages and bladders being reused for less energy than that of recycling these materials into new products.

- All HDPE products produced by RBW are recyclable as they are produced with 100% HDPE. RBW does not currently have the equipment that can shred dense plastic to recycle it however.

WATER CONSERVATION

- Virgin HDPE production is water-intensive, requiring 2,500 - 3,000 liters of water per tonne of plastic produced.
- Recycling HDPE significantly reduces water consumption, using less than 200 liters per tonne (approx.), leading to an estimated 2.3 million liters of water saved annually based on current production rates.

10.2 PROJECTED ECONOMIC IMPACT

The economic impact of this project is driven by the creation of recycled products that would otherwise be made in other provinces, countries, or on different continents. The projected economic impact of this project is multifaceted:

REVENUE GENERATION

- Sales: As the emphasis on a circular economy increases within Alberta industry, driven by GHG reduction targets and corporate goals of environmentally-responsible purchasing practices, the demand for recycled plastic products will increase
- Job Creation: establishing more recycling and product-manufacturing facilities will create new jobs. These green jobs will resonate with young, environmentally-conscious workers. Having facilities dedicated to washing and volume reduction located in proximity to waste management facilities would reduce the need to ship waste to other locations within or outside the province, and could create jobs in local communities. Due to the higher cost of plastic extrusion machines, it might make sense to have centralized locations where recycled plastic products would be produced.

COST SAVINGS

- Reduced Raw Material Costs: businesses who use virgin plastics in their manufacturing process can purchase ground recycled plastic material to be used in their processes. Because this material is clean and sorted by colour and type it should be easy to determine its properties, including MFR, to ensure it meets the needs of the manufacturer. The lower cost of recycled plastic flake compared to virgin plastic feedstock will reduce production costs and make these Alberta-based products more competitively priced.

- Infrastructure Savings: As municipalities start recycling more types of plastic the volume of material going into landfills will be reduced, slowing the need for further costs to expand landfills and reducing costs associated with waste disposal.

FUTURE ALBERTA INVESTMENTS

- Increased plastic recycling occurring entirely in Alberta, showcasing of successful projects and Alberta's commitment to sustainability could attract investors or new green industries to set up shop in Alberta. This would further increase job creation within Alberta and contribute to Alberta's overall image as a sustainable province that has many manufacturers and suppliers of recycled products.

ECONOMIC DIVERSITY

- Increased recycling and moving towards a circular economy could reduce Alberta's reliance on resource extraction industries and increase focus on the manufacturing of recycled products within the province.

TAX REVENUE

- With Alberta attracting more green investments and businesses, there would be increased corporate tax revenue for the provincial and federal governments. As new facilities are built and developed to manufacture recycled products, there would be increased property tax generation for municipalities. As people are employed to recycle the plastic and manufacture the products there would be an increased tax base and opportunities to decrease local unemployment levels.

10.3 RESULTED INNOVATION CAPACITY

This project has resulted in increased innovation capacity in the province and can inspire future advancements and sustainability in the following ways:

TRAINING OF PERSONNEL

Through the course of this project, RBW's Ph.D. Chemist attended a full-week plastic recycling seminar that focussed on extrusion technology. The seminar provided extensive education on the different properties of plastic and why it behaves the way it does. This knowledge and the troubleshooting techniques learned were invaluable to the success of RBW's Plastic Recycling project. Learnings from this seminar helped direct the purchase of a Chiller and provided insight into the challenges encountered during the process that resulted from working with different "types" of HDPE.

RBW also took a promising young employee, asked her if she would be willing to be part of the nascent Plastic Recycling process, and promoted her to a leadership role in running the production line. Prior to RBW's Chemist attending the full-week plastic recycling seminar, most of this operator's learning was through trial and error. With the increased knowledge received at the seminar, the Chemist was able to help provide a scientific rationale for why things were occurring, and proposed solutions for how to reduce issues encountered during the extrusion process.

As the Plastic Recycling project expanded, RBW hired a new employee who had experience in the field of virgin plastic product manufacturing. His expertise has been invaluable in troubleshooting and maintaining some of the specialized equipment associated with the Plastic Recycling Line. His creativity and attention to detail have led to the design and prototype development of some of the more complex products RBW has produced from recycled plastic lumber. Customized pallets, including the battery tray pallet, picnic tables, and planters are among the products this employee has designed and built. He has also trained his co-workers in manufacture of these particular items. Cross-training at the backend of the process has created a small team in which each member is capable of operating every piece of equipment and filling every role. This contributes to the resiliency of the department, and the satisfaction of employees working within it.

Over the past 18 months of working in our Plastic Recycling process, RBW employees have learned to troubleshoot Extruder issues, understand the correct temperature and pressure requirements for different types of HDPE and can perform maintenance on the different pieces of equipment used in the process. These employees have knowledge and experience that could be transferred to future commercialization projects with different plastic types and properties to produce different products.

Although RBW had consulted with other plastic recyclers in the province at the outset of putting the recycling process online, RBW's system was very different from theirs. RBW is recycling only specific types of HDPE, while other recyclers in the province have more diverse feedstocks that consistent of many more types of waste plastic. Their process and products are very different from RBW's, so their recommendations were not as transferable to RBW's process as initially anticipated. From what RBW personnel have learned through the development, implementation, and full-scale operation of an HDPE-specific Plastic Recycling Line, the company now has a project team, and an operations team who are highly skilled in the field of HDPE extrusion recycling. These individuals are all capable of sharing their experience, wisdom, and expertise to help troubleshoot new plastic recycling projects and of transferring their knowledge to increase the amount of plastic being recycled throughout the province.

KNOWLEDGE DEVELOPMENT AND POTENTIAL TRANSFER

RBW's HDPE sorting process was developed and optimized throughout the course of this project. Although RBW had been sorting HDPE prior to the project, nothing was sorted by colour. RBW Processing employees have become experts in sorting plastic, by both type and colour. Sorting by colour allows for the production of different-coloured products without the high cost of dyes. Experimenting with different mixes of various colours of ground plastic flake has resulted in the development of specific mixes that include the appropriate ratio of different colours of flake make different colours of extruded products. In addition to allowing control over the colour of the finished extruded products, the sorting protocol that RBW initiated at the outset of this project will allow for the determination of how much of the initially blow-molded plastic (drum and tote bladder material) can be introduced to the Extruder feedstock mixes before it starts negatively affecting the extrusion process. This knowledge and research are transferable to other current or future plastic recycling projects within the province. As similar projects are undertaken and become successful in Alberta and more individuals have plastic recycling skills and knowledge, it will attract more likeminded businesses and operations.

GREEN STARTUP COMPANIES

This recycling project serves as an example to motivate new businesses to keep circularity in mind when looking at waste management, sustainable product creation, or recycling technologies. The successes and learnings that occurred throughout this project will foster innovation and add a voice to a recycling industry that calls for manufacturers to create products that are easily reusable or recyclable. RBW's unique position as a waste management company who has internally developed a customized recycling process for waste HDPE offers a prototype circular business model that includes waste collection in which waste is converted into products that can be sold back to the waste generator.

10.4 SOCIAL IMPACT AND EDI OUTCOMES

This project is an example of a system that can work in smaller communities with waste used as a feedstock and employees turning that waste into saleable products to return to the generators of that waste. Having projects such as this working on smaller scales further reduces GHG demands and provides employment and economic diversity in smaller communities.

11.0 SCIENTIFIC ACHIEVEMENTS

There is a great potential to share what the RBW project team has learned during this project. From understanding how the plastic product was originally produced, the MFR can be predicted and sorted. Grouped plastics can be mixed in different ratios to optimize the properties of the product being produced. RBW has learned how to remove residues from these plastics in an efficient manner using minimal quantities of water. This washing step is important, as RBW, unlike other plastic recyclers, is not taking previously rinsed plastic that contained food products, but is cleaning oil, lubricant, and various other chemicals found in Alberta's industries from these plastics and turning them into clean products that can be resold.

12.0 POST-PROJECT STEPS

12.1 NEXT STEPS AND FOLLOW-UP PROJECTS

The next steps for RBW's HDPE recycling project include pushing the limits of how much blow-molded HDPE (Drums and IBC Tote bladder) material can be incorporated into the Extruder feedstock to ensure that RBW can still produce a quality product while maximizing the amount of plastic that is recycled based on the type of HDPE received at the facility. Since different "types" of HDPE waste are not received in consistent ratios, RBW needs to develop versatile blends of HDPE that will work when different types are received in different quantities.

Given RBW's success at increasing production capacity beyond initial expectations, the company is excited about the prospect of researching more HDPE waste streams and sources within Alberta and determining if they can be introduced into the process to keep production at current levels without sacrificing product quality. There is also an opportunity to connect with Alberta's Extended Producer Responsibility (EPR) program that focusses on the recycling of certain types of residential waste, including mixed plastics. RBW's Plastic Recycling process was developed based on an exclusively HDPE feedstock as that was the plastic waste stream RBW was already managing as a waste provider. By connecting with the EPR program, RBW would have access to different types of plastic, which would provide opportunities to experiment with different blends of plastic to improve the quality of finished recycled plastic products, and different blends may also result in the ability to make new products that are more difficult or impracticable to produce with HDPE alone. RBW is already in relationship with ARMA, who is currently responsible for overseeing the EPR program. RBW is currently registered with ARMA both as a collector of paint, and as a processor of engine filters and eligible plastic material.

Using existing feedstocks and without necessarily diversifying our customer base, future initiatives related to RBW's Plastic Recycling program include determining other simple products that can be produced and sold back to the industries that produced the feedstock as waste. Such products might include small jersey barriers or chock blocks.

12.2 PARTNERSHIPS

RBW is currently a member of ARMA and BCUOMA, organizations that provide rebates for recovering and recycling oil plastics in Alberta and BC respectfully. RBW takes part in regular stakeholder engagement sessions with ARMA that focus on increasing the success of plastic recycling in Alberta and look for ways to increase the amount of plastic recycled in Alberta through the use of EHCs, so that there is more incentive in other industries to recycle non-oil plastics. Currently only oil plastics have a recycling incentive associated with them.

13.0 OVERALL CONCLUSIONS

The RBW HDPE Recycling Project was successful. It achieved and surpassed expectation of most of the projected outcomes described in the original contribution agreement with the ERA. The project provided funding that allowed RBW to take the HDPE material that was being collected, decontaminate them and turn it into valuable products to be resold to the same customers who produced the waste.

The monthly target for weight of recycled products manufactured exceeded the objectives and is currently double that original projected outcome. The project team strived for 8,000 kg of recycled material and is thrilled to be almost doubling that target at this point. The project exceeded the monthly target of the weight of recycled plastic products by focussing on curb stops production rather than 2” x 4” and 4” x 4” boards, which are much lighter and require more labour per unit weight to produce. RBW currently manufactures an average of 16 tonnes of plastic curb stop products per month.

The sales of recycled plastic curb stops are currently undefined due to their sales season just beginning but are projected to be highly successful due to the superior properties of the product compared to the concrete curb stop, and competitive pricing. The sales that RBW has seen in curb stops have been to oilfield supply companies in Grande Prairie, Edson, Whitecourt and Dawson Creek which service local industries. It is anticipated that in the coming spring/summer season these supply companies will receive large orders for curb stops to refurbish existing parking areas or as new installs for new facilities. End user sales of curb stops have included RBW Customers who saw an opportunity to use recycled plastic curb stops in their warehouse to protect walls from forklift damage. RBW salesmen are approaching construction and parking lot maintenance companies to try to increase the volume of curb stops sold per transaction, reducing required labour, handling and transportation costs along with the associated GHG emissions. It is anticipated that RBW will grossly exceed the projected monthly sales of curb stops, especially, during spring, summer, and fall. Times of year during which sales are slower will be spent restocking product for the optimal sales seasons.

RBW designed and developed a number of different products using recycled plastic lumber as the raw material. Among these products are standard 4’ x 4’ pallets, custom-designed battery tray pallets, picnic tables, and more recently, planter boxes. With respect to the battery tray pallets in particular, RBW had been struggling with handling plastic battery trays full of waste industrial batteries. The full trays were heavy, did not stack well, and require pallets between them to facilitate transport by forklift or pallet jack. Wooden pallets were presenting challenges. They were not the correct size, they also did not stack well with the battery trays, and they frequently broke under the weight of a full battery tray. Prior to initiating this plastic recycling project, RBW had been exploring ideas as to how to solve this issue. Redesigning the battery tray would have been cost prohibitive and resulted in hundreds of obsolete battery trays that would need to be taken out of service and disposed of. Custom-built wooden pallets or out-sourced plastic pallets were also an option, but were similarly cost-prohibitive, without presenting an optimal solution in terms of stacking challenges. Once this project was underway, RBW decided to design a pallet specifically for use with battery trays using HDPE 2" x 4"s that could withstand the weight of a full battery tray, that would stack securely, and that would not splinter or break while being lifted. These pallets have been put into operation in the coal mines in the Sparwood Area and the reviews from Drivers have been extremely positive. RBW has put 65 of these pallets onto customer sites for use and are continuing to make more pallets daily to meet demand. This is an example of waste from industry being recycled and used in lieu of virgin products in the same locations as the original waste was generated. RBW is extremely pleased with this recycled HDPE battery tray pallet as it is made with recycled contaminated material, is designed for continuous reuse and can be repaired as required, it eliminates single/limited use wood pallets and these pallets can be re-recycled if they are ever destroyed so there will never be a need to landfill these materials.

This project has succeeded in the creation of jobs in Alberta. RBW projected that at least one full time position would be created through this project. Three Employees have been hired and trained as a result. These employees are now knowledgeable and possess transferrable skills related to the field of plastic recycling. Another Supervisor has received training focussed on Plastic Extrusion and is also able to operate the extruder. These skilled and trained plastic recyclers understand how to deal with issues with recycled materials as they arise. Two of these employees had no experience in the industry and were general labourers before this project and the third employee had no recycling experience but did have knowledge of the virgin plastic industry.

RBW initially exceeded the objective of material sent offsite for recycling with 100% HDPE waste being recycled onsite. Now RBW is sending 23% of HDPE offsite for reuse. RBW original goal was to have less than ten percent of HDPE shipped off site for recycling. IBC tote bladder HDPE Waste sent for reuse is being shipped less than 10 kms offsite for reconditioning. This holds a lower environmental impact than recycling as it requires fewer resources and energy, and less waste is produced as a result. Based on the waste recycling hierarchy, this alternative recycling option directly contributes to a circular economy. RBW made the decision to send IBC Tote for reconditioning rather than recycle it as the project team knows that a combination of reuse and recycling was more sustainable than simply recycling 100% incoming plastic waste.

The project has resulted in a significant GHG reduction achieved by replacing curb stops made from virgin plastic or concrete. RBW is extremely pleased with the environmental outcome of this project. The GHG reduction associated with 2"x 4" and 4"x 4" production is based on GHG being decreased as virgin plastic was not required to be produced, so ocean freight of this virgin material was not required. This GHG benefit was then reduced by the GHG produced by the energy required for HDPE recycling. This results in a 292 tCO_2 net emission reduction per year with an average 8,716 kg of 2"x 4" boards manufactured per month. Since RBW decided to change production to focus solely on HDPE curb stops, production capacity has increased. With the 2"x 4" production alone, this project had the GHG equivalent of taking 63 passenger vehicles off the road annually. With the production shift to curb stops being compared to concrete emissions, this has doubled and is closer to removing 127 vehicles from roads. The RBW HDPE recycling project can currently produce an average of 4000 kg of curb stops per week. This results in a 11.4 tCO_2 per week or 592.8 tCO_2 per year in equivalent GHG reduction.

The HDPE Recycling project has been an extremely positive achievement for RBW through increasing the sustainable practices and providing circularity that RBW customers want to see in the resource extraction and industrial sectors within Alberta and its surrounding provinces. The HDPE recycling along with HDPE material sent offsite for reconditioning reduces the environmental impact of these industries. Without the funding from the ERA, this project would not have been financially viable, even with the infrastructure that RBW already had in place.

This project should serve as an example to Alberta's industry as to how circularity can be established to reduce GHG emissions, promote sustainable practices and resource efficiency, and improve the economy through local job creation and gaining of transferrable skills and knowledge.

14.0 COMMERCIALIZATION AND TECHNOLOGY TRANSFER PLAN

14.1 PROJECT COMMERCIALIZATION ADVANCEMENTS

RBW has shown that introducing circularity into waste management is possible and can be successful. There have not been any issues moving this project to commercialization. RBW chose to focus on curb stops as the product utilizes up to 70 lbs of HDPE per curb, the shape is easy to extrude and due to how thick and solid it is, it is not subject to the warping that can occur with recycled plastic that occurs as the temperature increases in the sun or it is bearing significant weight. This product simply needs to be secured in place with rebar and it will stop vehicles from hitting curbs, fences or buildings.

RBW's current commercialization focus is securing additional sources of HDPE so that curb stop production will not need to slow down and to fine tune the process to reduce the labour required to finish the products once they are removed from the mold. This includes putting more material handling equipment such as rolling tables and tables with adjustable heights to make operations more efficient and reduce the potential for employee injuries.

The final hurdle for the RBW HDPE Recycling Project is the commercial deployment of the curb stops. There is no doubt that once the curb stops are in place, they will outperform the rubber and concrete alternatives. They are also priced lower than the alternatives, to make them more desirable than the non-recycled alternatives. Yet RBW has never sold this type of product, and the industry is different than the current customer base. RBW's sales team is dedicated to ensuring that this product is visible in the market both to companies who perform parking lot maintenance as well as end users in the ICI sectors of Alberta. They are calling their customers, making contacts and performing cold calls to try to get the recycled HDPE products into the market. RBW's target for commercialization success metric and achievements to date can be seen in Table 7 below. RBW has the trucks, the handling equipment and trained employees ready to deliver these products all over Alberta, Saskatchewan and Eastern British Columbia once sales have been secured.

Table 8: RBW's HDPE Recycling Project Commercialization Success Metrics

Success Metric	Commercialization Target	Achievement to date
Percent Plastic Shipped off site for Recycling	25%	22.6 % of HDPE is being shipped less than 10 Kms from the RBW Plant for IBC Tote Reconditioning
Weight of Recycled Plastic Products Produced	5 tonne/ month	RBW currently produces an average of 16 tonnes/month by focussing on curb stop production
Created Additional Full-time position	1	RBW has 3 full-time employees working on plastics. One employee grinds, makes ground mixes and finishes products, the second employee extrudes HDPE into molds and the third builds products such

		as pallets, picnic tables and drills holes and cuts end on curb stops
Sales of recycled plastic products to distribution company	2 tonnes/month	1 tonne was sold in November 2024 to distribution companies to be used to sell large amounts of curb stops. April-October is the optimal sales period for this product. RBW hopes to surpass this sales target in the coming months.

The current market is flooded with rubber or concrete curb stops. Concrete curb stops crack and break when contacted by equipment (used to clear snow in the winter) and rubber curb stops do the same. The rubber curb stops break down overtime due to heat and sunlight as well. The recycled HDPE curb stops are light weight and therefore easily to install without the use of equipment, they do not crack or break and they are not degraded by sunlight. The market currently has very few plastic curb stops, so market adoption will be a bit of a challenge at first as installers are used to installing a particular product, but the environmental sustainability, superior product and the low price should be able to get the product into the market. Eventually it will become the standard that curb stops are made from recycled HDPE. RBW is able to create 25 high-profile curb stops per day within an 8-hour shift. Should RBW have the need to scale up curb stop production, the amount of curb stops produced daily could be tripled with the current equipment by hiring more employees and having 3 shifts operating per day.

Commercialization for RBW was achievable through funds received by this grant but could also be made possible by other means for different companies. Increasing the type of plastics in which rebates are available is one method that would improve the economic viability of similar projects and improve the commercialization of similar projects. Alternatively making non-recycled plastic material less attractive to industries through increased tax on virgin HDPE products, or other virgin plastic products could increase the desire to use recycled material.

Although the resource extraction industries are motivated to improve their environmental performance, there are many industries within Alberta that have little to no incentive to recycle. This is likely a place where plastic waste is still largely ending up being landfilled. There is a significant opportunity for governing bodies to make changes that will incentivise these industries to make use of available recycling options. Currently, the cost of recycling exceeds the cost of landfill disposal, and local recycling options do not exist for all the waste that could possibly be recycled. In a competitive environment in which landfill tipping fees are relatively low, the prospect of recycling waste is often a financial burden companies are unwilling to assume when they and their competitors are not required to do so. Rebate incentives exist for a few products in the marketplace, like electronics, passenger tires, paint (of certain types and quantities sold to end-users), and some plastic products. These rebate incentives are recovered by companies who offer recycling solutions and help to offset the cost of recycling processes while remaining competitive in a market in which landfill disposal is also a viable option. Regulators can create a more robust incentive framework in which materials are covered by the program based on whether recycling options exist for them or not, rather than by who buys them or disposes of them as waste. There is also an opportunity for more consistency in rebate programs across the country. As an example, there are plastic products covered by rebate incentives in British Columbia that are not covered in Alberta.

Mandated recycled content standards such as requiring specific industries to include a minimum percentage of recycled plastic in their products is another way to reduce the use of virgin plastics in Canada. Tax credits or grants to use recycled material or to recycle waste can also be used to incentivise industry to improve their plastic recycling or use for recycled plastic efforts.

14.1.1 PROJECT TECHNOLOGY ADVANCEMENTS

The advancement that took place in this project was to design and deploy a sorting, decontamination and HDPE recycling program that introduced circularity in plastic waste found in the ICI sectors in Alberta. RBW has proven that this can be achieved in a short period of time with a company that is correctly positioned in the waste management field with customers are motivated to recycle wherever possible.

14.1.2 PROJECT TRL ADVANCEMENTS

At the beginning of this project the technology readiness level (TRL) was at an 8, where the actual technology existed and was already proven to work with specific plastic types. By the end of the project, the TRL was at a level 9 where the technology was proven to work with Alberta industry-specific HDPE waste that was sorted and blended to make specific products. The project including taking different technologies that previously existed and combining them to create a process to successfully recycle contaminated HDPE waste.

14.2 TECHNOLOGY PROVISION AND THIRD-PARTY VENDORS

RBW has a sales team that will continue to look for opportunities for the current recycled HDPE products being produced to be used. They will also look for alternatives products on customer sites that can be made through extrusion or with molded rHDPE boards. These products can be built to order and delivered while waste is being picked from customer sites, reducing the need for any added transportation costs or associated GHG emissions.

Third party vendors such as oilfield supply, construction or parking lot maintenance companies are examples of industries that will help to make HDPE product sales a success. RBW currently has existing relationships with many Alberta and northern BC oilfield suppliers and has a few local construction companies as vendors for industrial supply. RBW has been speaking with their contacts to get the available products into the market and to end users.

14.3 COMPETITIVE SCAN

Competition in RBW’s market is provided by other hazardous and non-hazardous waste management companies that operate in the ICI sector in Alberta. To RBW’s knowledge, none of these companies offer an in-house plastic recycling option. Where plastic recycling occurs, it typically involves shipping material out-of-province to places like Ontario where a more developed recycling industry exists. The advantage RBW has compared to others in this industry is the desire to improve environmental performance and recycle as much as possible. RBW is also a privately-owned company based in Alberta. This ownership type eliminates the red tape and corporate bureaucracy larger companies face when attempting to implement new technology. RBW’s management fosters an environment of innovation among employees and is willing to support initiatives that look promising. RBW’s management structure is also such that employees are empowered to pivot when encountering opportunities or challenges, and to make changes to operations that will increase the company’s competitive advantage, production capability, or ability to provide recycling alternatives for material otherwise handled as waste. As an ISO14001-certified company, RBW develops and implements multiple environmental programs every year to increase sustainable practices.

As far as technology transfer, RBW is excited to promote the opportunity to offer circular plastic recycling options to smaller communities, industrial supply partners, and First Nations communities. The capital expenditure to establish a similar recycling line might be prohibitive to these companies and communities, but a plastic recycling partnership could be developed that leverages RBW's ability to produce recycled plastic products, and community resources including being sources of raw material and labour to finish products or design/create/build more complicated, value-added products from the recycled plastic RBW generates.

14.4 MARKET AND END-USERS

Market end users are the resource extraction and the ICI sector within western Canada, including the construction industry, municipalities, and parking lot maintenance companies. RBW currently services all of Alberta, Saskatchewan, Eastern BC and Western Manitoba. Realistically RBW can provide recycled plastic products to any of these locations without having to make inefficient deliveries.

14.5 MARKETING

RBW provided flyers to RBW sales team in early November of 2024 for the recycled plastic curb stops that were then being made (see Figure 3). This resulted in sales to supply companies which RBW hopes will result in larger spring sales. RBW's website is being updated to include the recycled plastic products that have been produced, as well as information regarding the Plastic Recycling program generally. The sales teams have been told by parking lot maintenance companies that they are not interested in discussing this product until mid April when they will finish dealing with winter maintenance and start working on spring maintenance. As the sales team encounter spring break-up, they are shifting their focus on learning more about the curb stop industry and who the suppliers of this material is in hopes of gaining large sales volumes.

14.6 DISTRIBUTION

RBW has a fleet of cube vans and semi trucks with van trailers and flat decks. The van trailers are outfitted with power pallet jacks to move around heavy materials such as curb stops. The flat deck trucks have Moffett truck mounted forklifts attached to the trailers designed to take heavy materials off the trailers and place them on customer's sites. RBW currently dispatches trucks on routes based on delivery schedules and orders to optimize Driver time and fuel efficiency. The curb stops would be delivered with the other orders during a regular schedule. RBW is delivering bins or product to Southern Alberta twice a month and Northern Alberta once per week. Drivers travel to Saskatchewan and Southeast and Northeast British Columbia every week and make deliveries and pick ups all along the way. RBW has several Class I and Class 3 Professional Drivers that are trained to transport materials to different locations with varying types of receiving capabilities, so transporting and moving heavy curb stops in different volumes will be efficient and simple to implement.

RB Williams Industrial Supply (RB Williams) is the sister company of RBW. They are a wholesaler which distributes products to smaller suppliers that sell products locally to energy sectors all over Alberta, Saskatchewan and the eastern portions of British Columbia. RB Williams is hoping to expand its current sales with construction companies to include sales of curb stops and other recycled plastic products and gain new customers that perform parking lot maintenance and new install during the construction phase.

RBW drops off hazardous waste recycling bins and products and picks up waste from remote sites that perform resource extraction. RBW is hoping that their customers current customers can use curb stops in building or outdoors to prevent equipment from contacting utilities or fences on site where they would normally use large heavy jersey barriers that require equipment to install. Larger facilities would have the need for picnic tables and parking areas for their employees and contractors. RBW believes that these customers will want to use the recycled products as it shows their desire to reduce their footprint by recycling and using recycled products made from their waste. This is important to employees, shareholders and people living in the communities that these operations exist.

14.7 TECHNOLOGY PROTECTION

RBW's process to sort and recycle HDPE is the proprietary system that the ERA grant helped to fund. This process is unique and is very specialized to RBW's equipment, facility and type of waste received. Therefore, its unlikely that the exact formula that works in RBW's situation will work in another scenario but there will be transferable learnings. RBW does have issues with sharing the learnings that have resulted from this project. There is no technology protection required as the recycling system was designed with equipment that is readily available for purchase.

14.8 COST OF COMMERCIALIZATION

The cost of commercialization of this project is difficult to define as RBW had much of the infrastructure in place prior to start of the project. This project cost $1.47 million, with RBW already having buildings, licensing and approvals in place before the project began. Before beginning the project, RBW also had operational shredding and washing equipment, trucks and trained employees available to bring in waste and drop off product. It is estimated that getting this project started from scratch would require more than $2 million in resources and assets prior stating this project.

There were few sunk costs related to research and development. RBW did try to create boards with 100% HDPE from IBC tote material and later Drum material. The project team found that the plastic did not flow and immediately stopped working with this material. A conservative estimate for this trial-and-error step was about one week of labour for two individuals, representing about $2,800 in sunk costs.

RBW produced 2" x 4" and 4" x 4" boards in the initial stages of this project and decided to move to producing curb stops as the project progressed. The recycled plastic lumber that was produced early on in the project is being used to create custom pallets and picnic tables that are currently available for sale.

The revenue potential is based on the plastic product manufactured and what industries the waste is coming in from. As mentioned previously, "oil" plastics are sold with an environmental handling charge (EHC) that is collected and subsequently distributed by ARMA to plastic recyclers in Alberta. If a company can obtain, as a feedstock, plastics that are included in this program, receiving rebate incentives from ARMA should allow for a reduction in final product costs. This lower cost will allow the recycled product to compete with similar products made from virgin plastic. Consumers are more likely to buy recycled plastic products if they have a similar or lower price compared to virgin plastic options. If a company can collect rebates for collecting plastic waste and delivering it to a downstream processor (recycler), there is potential to create a good revenue stream, and to increase the amount of plastic waste that is ultimately recycled.

Since RBW has not yet experienced an entire year of selling plastic products, and this product is new to the RBW product line, the return on investment can only be estimated based on cost reductions, rebates and potential sales. RBW receives an average of 164 tonnes on HDPE annually. RBW was paying $7875 per year to transport plastic off-site for third party recycling.

14.9 SHORT-TERM ACTIONS

RBW will continue to better understand who the buyers of curb stops are and where else this product can be used within Western Canada's ICI sectors and in commercial settings. Since creating these curb stops RBW has recognized different application opportunities, including their use in preventing damage to walls, fences and equipment, and temporary parking lot use during construction or improvement projects on large sites as they are easy to install and remove once projects are complete. RBW's current customers do occasionally have new construction on larger sites or plants but this is not constant so it will be imperative to find more customers that require large amounts of curb stops on a regular basis, such as parking lot maintenance, asphalt installation or construction companies.

14.10 LONG-TERM COMMERCIALIZATION

RBW will continue to look for different marketable products that could be created with HDPE waste through the extrusion mold process that will have properties that would allow for good products. Curb stops are great as they sit on the ground and are heavy and solid. These products should not have the risk that smaller products such as 2" x 4"s have with warping. So RBW will continue to talk to RBW customers about products that would be desirable and try to create them.

RBW initially planned to create chock blocks to be used to prevent equipment from rolling on customer sites. We decided to stop exploring this option early on as the HDPE was light and can easily slide when being pushed with equipment if not secured. It is possible that we try to use rubber in conjunction with the plastic to try to increase the friction and weight of the product and get the product engineered to meet required specifications.

15.0 COMMUNICATIONS PLAN

15.1 KNOWLEDGE SHARING DURING PROJECT

Since the ERA released information regarding this grant, RBW has been approached by multiple plastic recyclers in Alberta and has attended two annual Alberta Circular Plastics Day. Different companies approached RBW at these conferences, expressing interest in finding potential recycling solutions for their particular plastic waste, selling their waste plastic to RBW, or selling RBW their used equipment. These contacts have given RBW potential waste solutions for other types of waste plastics that RBW does not currently recycle.

RBW has also given a few tours of its operation to other plastic recyclers in the province who have offered ideas and shared their information about their operations with the project team. Although understanding how other operations work is valuable information, the project team determined at an early stage that the process required to recycle plastic is very unique to the type of waste being used. Another recycler who was making curb stops and designed RBW's low profile curb stop, shared his process with RBW and it did not require a chiller to cool the plastics. He was using a mixture of HDPE and Polypropylene, however. This mixture worked really well for his plastic lumber products. When RBW tried to create plastic lumber without cooling, the lumber warped. For RBW's waste type the chiller was imperative to the process. Without the chiller our products would warp and take multiple hours to cool, reducing the quality of the product and the efficiency of the process.

15.2 KNOWLEDGE SHARING POST PROJECT

RBW intends to share this project and the results with local media once there have a few more product sales so that market can be better explained. RBW is already sharing news about the recycled plastic products produced via the RBW website. RBW and RB Williams salesmen are actively sharing the information for this project with existing and potential customers so that they can share in the success of RBW. In the case of existing customers, the sales representatives approach the topic as a collaboration, as it is our existing customers' waste that is being recycled into these recycled plastic products.

16.0 LITERATURE REVIEWED.

[1] https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/reduce-plastic-waste.html Visited Aug 10, 2022.

[2] The Daily — Waste Management Industry Survey: Business and government sectors, 2018 visited April 16, 2025

17.0 DEFINITIONS

- **Die:** The die of the extruder is the opening the hot plastic is pushed through to fill a mold. The shape an size of a die can be changed to make different plastic shapes.
- **EHC-** Environmental Handling Charge
- **EPR-** Extended Producer Responsibility- an environmental policy that shifts the responsibility of waste management and recycling from governments and consumers to producers and manufacturers of products.
- **Extrudate:** Extruded resin. Basically, the plastic as it is coming out of the extruder's die and fills the mold
- **IBC Tote–** Intermediate Bulk Container tote. This refers to the inner HDPE liner or container used for storing and transporting liquids. This container is typically 1000 L. The container is housed in a steel cage.
- **ICI Waste:** Industrial, Commercial and Institutional Waste
- **Melt flow rate (MFR):** Also referred as Melt Flow Index, it is a measurement of the resin's ability to flow under pressure. The higher the number, the easier it flows.
- **rHDPE:** Recycled high-density polyethylene
- **Shear control:** When the flow properties of the melt plastic are driven by the screw speed rather than the barrel temperature. (Screw turning generates shear heat, in some resins depending on the working temperature, this is more important and if this scenario happens, it is called "shear control")
- **Short shot(s):** Common issue; it is when the extrudate or resin do not fill the mold completely, resulting in incomplete parts/product.