Ontario Agricultural Waste Management Study – Phase II: Risk Assessment, Collection, Processing and Stewardship Options

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Executive Summary – Phase II

Currently, there are limited opportunities in Ontario to collect, recycle and safely dispose of agricultural wastes generated by farmers. There are, however, some permanent programs for rinsed pesticide containers, obsolete pesticide stocks, used oil, filters and containers, and used on-road and off-road tires.

While these existing programs provide solutions for some designated products, there are still a large number of other agricultural waste materials that do not have any environmentally sound 'end of life' solution. Disposal practices for these products are decided at the farm level, with minimal support from others. These on farm practices include landfilling and uncontrolled burning for materials which have the potential for releasing a broad range of pollutants into the environment.

In the Great Lakes watershed areas of Ontario, these pollutants are of significant concern as they ultimately affect the water quality of the Great Lakes and have the potential to impact all of those who depend on this resource.

Recently, Extended Producer Responsibility (EPR) principles have begun to be applied to the management of agricultural wastes and placed greater responsibility on those whose products are generating these wastes; the Stewards.

The work carried out under this Study supports the enhancement of environmental protection within the Great Lakes through the development of a management plan for potentially harmful pollutants that originate on farms and that could cause potential degradation of the waters of the Great Lakes due to improper disposal.

The Ontario Agricultural Waste Management Study is divided into two separate phases. Phase One quantifies and analyzes the agricultural waste materials currently being generated on Ontario farms, while Phase Two evaluates the feasibility of establishing and administering a stewardship program to sustainably mange these materials. A risk assessment of broadly available material has been undertaken, together with a logistical and cost assessment of possible collection and processing systems.

Waste Stream	Material Description	Province Wide Management System	Estimate Volume (in Tonnes)
Miscellaneous			
Pesticides	Chemical	YES	117
Engine and Hydraulic Oil	Oil	YES	not available
Sanitation Products	Chemical	NO	fully consumed
Plastic			
Film Plastic – incl. Silage/Bale Wrap	LDPE	NO	3,510
Woven Bag Plastic	PP	NO	490

Twine Products – incl. Net Wrap	PP	NO	1,227
Pesticide Jugs, Pails and Drums	HDPE	YES	275
Sanitation Products Jugs, Pails and Drums	HDPE	NO	1,115
Oil Plastic Jugs, Pails and Drums	HDPE	YES	360
Greenhouse and Nursery potted plant insets, trays pots etc.	PP, PS	NO	505
Potted Plant Sleeves	PP, LDPE, HDPE, PS	NO	60
Paper Fibre			
Kraft Paper Bags – unlined seed bags	Paper fibre	NO	400
Kraft Paper Bags – lined bags	Paper fibre and plastic	NO	240
Cardboard Boxes	Paper fibre	NO	4,780
Cardboard Boxes Waxed	Paper fibre, coated	NO	1,050
Animal Health Products			
Animal Medications	Pharmaceutical	NO	1
Glass Bottles	Glass	NO	1,097
Plastic Bottles	HDPE	NO	67
Sharps	Bio-haz	NO	9
Packaging - bags, plastic bottles, inserts, tubes, boxes	Mixed Stream	NO	20
TOTAL			**15,323**

Of the materials not currently serviced by a province wide management system, there are over 14,000 tonnes of waste agricultural packaging and animal health product generated annually in Ontario that is potentially recoverable. Not all of these materials are currently recyclable as a result of technical processing challenges; however, all of these streams can be better managed by improved end of life handling processes, than what on farm burning and landfill offer.

While the effects of open burning plastic in an agricultural setting are limited, a review of available literature indicates that highly toxic organic pollutants are released to the environment through the on farm burning of plastic such as heavy metals, dioxins and furans. Dioxins and furans are a health concern even in very small quantities, being associated with endocrine disruption, heart disease, cancer and cognitive and motor disabilities in humans. In addition, these chemicals pose a serious threat to aquatic species, wildlife, and soil fertility.

Dioxins and furans are also considered a Tier 1 pollutant by the Canada-Ontario Agreement Respecting Great Lakes Basin Ecosystem which suggests that the pollutant is a persistent bio-accumulative toxic substance.

When end of life management options consist primarily of burning and landfill there is a lost opportunity for recycling. The most direct impact of this is the associated higher production of CO2e, increased consumption of raw materials inputs and higher consumption of energy. To put this impact into context; recycling the approximate 13,500 tonnes of plastic and paper fibre wastes, generated annually

on Ontario farms, is estimated to yield environmental benefits equivalent to saving over 75,000 barrels of oil or avoiding the pollution from 7,919 cars driving on the road for one year.

The recycling and disposal of non-regulated plastic and paper wastes can be managed through both an event based system and a fixed depot approach. Non-regulated material includes the packaging from glass, plastics and paper fibre products which have not come into contact with regulated chemicals or hazardous materials. For the above material, the event approach proves more effective in managing potential regulatory constraints, while for large volume non-regulated materials, a fixed depot approach provides better access, lower overhead and maximizes recovery potential.

The non-regulated material collected through a network of sixteen collection depots is estimated to cost between $469,000 and $1,114,000 depending on the value of recyclable commodities recovered. These estimates are based upon servicing a range of potential recoverable volume of between 10% - 65% of the available 11,000 tonnes of material.

Non-Regulated - Recyclable and Non-Recyclable Materials Program Cost Summary	**Cost**	
Processing Material Recovery Range	**Min. (10%)**	**Max. (65%)**
Non-recyclable waste items – (Cost)	($469,000)	($1,114,000)
Recyclables waste items - Net Processing Program Revenue (Cost)	($54,000)	$842,000
Collection and Processing Program Cost Summary	**($523,000)**	**($272,000)**

The disposal challenges affecting the best end-of-life management of some products like obsolete animal health products and packaging are compounded by the lack of a categorization system. A system is necessary to allow end users to differentiate between those products which must be carefully controlled through a licensed hazardous waste management system and those products and packaging which can be handled as non-regulated through traditional recycling.

Without a waste management strategy for animal health products, the potential cost for managing these materials balloons from a low of $478,000 to $10,226,000 under a regulated classification, as shown below. These figures are based upon a 100% collection volume of 2,076 tonnes of the select material. Industry and government regulators need to develop and implement a simple and effective system to facilitate the correct categorization and streaming of these materials at the farm level, prior to the application of any diversion and end of life management programs.

Animal Health Products and Packaging End of Life Management Costs

	Low Cost	**High Cost**
Volume (tonnes)	2,076	2,076
Packaging (for waste transportation)	($3,000)	($558,000)
Disposal Transportation	($265,000)	($204,000)
Disposal (incl. packaging weight)	($169,000)	($9,423,000)
Event Based Staging – 16 sites	($41,000)	($41,000)
Total Scenario Costs	**($478,000)**	**($10,226,000)**

Under an Extended Producer Responsibility (EPR) stewardship program, management of agricultural waste materials is the obligation of the Stewards (brand owners and first importers of these materials into the province of Ontario). Stewardship program development requires the following key items:

- Clear definition of the stewarded product;
- Targets for collection (accessibility and recovery targets);
- Promotion and education for all stakeholders (stewards and consumers);
- Financing by the stewards;
- Reporting of results.

Across Canada and throughout Organisation for Economic Co-operation and Development (OECD) countries, practice has shown that for EPR stewardship schemes to be successful, backstop regulation making the programs mandatory appear to be the only way to achieve reasonable success. There are, however, some exceptions and the CleanFARMS pesticide container and obsolete pesticide collection program are two.

Fortunately, this study has shown that there are collection and processing options available for virtually all of the products identified - no technical barrier exists to manage these products. The challenge in moving forward with a broader stewardship model is that new infrastructure and new collection programs will be required.

Managing these products through stewardship means that utilizing recycling and safe disposal will add costs to the stewards of the products. By introducing a mandatory program, plastic, paper fibre and animal health product Stewards will be required to align their practices and business models to support and promote sustainable end-of-life management program for all of the waste materials their products generate.

Through the implementation of mandatory programs through backstop legislation, all Stewards will be obligated to participate in an approved stewardship program. This will provide the legislative support, regulatory enforcement, funding and infrastructure required to promote Best Practices for end-of-life management of these waste and to assist the farmers to manage these materials in an environmentally responsible manner.

Ontario is currently in the process of introducing new legislation in parliament that would place even greater demands on agricultural stewards to manage the end of life of their products. The proposed legislation would see a number of products not previously managed become regulated under stewardship programs. This legislation would also empower industry to design, operate and lead stewardship programs under their own control. To accomplish this, industry will need to rely on an experienced, industry supported stewardship organization that can bring to focus the resources and logistics required to meet new government legislative demands.

Study Partners

CleanFARMS Inc. has prepared this report with the financial support of:

Ontario Ministry of Agriculture Farming and Rural Affairs - OMAFRA
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In partnership with:

Canadian Animal Health Institute – CAHI / ICSA

Ontario AgriBusiness Association – OABA

Ontario Ministry of the Environment - MOE

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1. Introduction

1.1. Background

The government of Ontario signed the 2007 COA Agreement, and extension, to restore, protect and conserve the Great Lakes basin ecosystem in order to assist in achieving the vision of a healthy, prosperous and sustainable basin ecosystem for present and future generations.

Agricultural industry groups and all levels of government recognize the need for collection and proper disposal of farm waste of a technological nature (i.e. used tires, oils, unwanted pesticides, healthcare products, used plastics etc.). Frustrating the resolution of these challenges is that historically, there has been no coordinated mechanism in place that provides for reasonable, cost effective options for farmers to turn to for the responsible recycling and disposal of such wastes.

Recent amendments to Ontario's Waste Diversion Act have strengthened the ability of government to apply Extended Producer Responsibility principles to the management of these materials and consequently place greater responsibility both practically and financially on those who are generating these wastes.

The work carried out under this Study supports the enhancement of environmental protection within the Great Lakes through the development of a chemical management plan for potentially harmful pollutants that originate on farms and that could cause potential degradation of the waters of the Great Lakes due to improper disposal.

1.2. Project Objectives

The overall objectives of this project are to:

- Quantify the types of animal health care products (pharmaceuticals, biologicals, animal pesticides, feed additives), agricultural packaging (paper fibre, plastic, steel and aluminum) and other agricultural plastics (bale wrap, greenhouse film etc.)
- Identify the stewards (manufacturers and first importers) of these products into Ontario
- Identify the potential collection schemes and processing options with associated costs and benefits including the amount of potential waste diverted, and:
- Explore the stewardship options for these waste materials including a risk assessment of each waste material

Through the exploration of farm generated waste materials with the potential to cause environmental impacts within the Great Lakes, this project will produce a comprehensive survey of all types of on-farm agricultural waste packaging materials including plastic wastes and how end-of-life management can reduce potential impacts to water quality through proper collection and processing of targeted materials.

The project will also explore the options for animal health product waste collection and options for recycling and disposal that can be supported and led by industry groups.

The project will further contribute to a reduction in other harmful pollutants and form a basis for initiating a program for managing chemical substances in the Great Lakes Basin. This will be accomplished by working with farm organizations and industry representatives to develop an enhanced program for the safe collection and disposal of agricultural products and containers that includes expired/unused veterinary pharmaceuticals.

1.2.1. Phase I Research

Extensive research has been undertaken during Phase I of this project and included: characterizing agricultural waste generated, such as volumes, and material types, investigating generator attitudes, practices and preferences in regards to the management of on-farm generated wastes, and, also a review of disposal practices and the practical, social and political constraints affecting the management of these materials.

The following table lists the studies that have contributed to the Phase II Study and which form a basis for the development of assumptions, and conclusions in the performance of the risk assessment, collection and processing options and the stewardship analysis.

This report is supported by the research and data gathered in Phase I and Phase II of this project. Excerpts and material utilized from these reports are not intended to be represented as this authors own work.

Table 1 – Phase I Research

Study Title	Researcher	Date of Release	Precis Attached As
Collection and Disposal of Unwanted Agricultural Pesticides and Animal Health Products in the Great Lakes Basin	eBiz Professionals Inc.	January 29, 2010	Appendix 1
Primer for Extended Producer Responsibility	CleanFARMS Inc. and CM Consulting Inc.	January 19 , 2011	Appendix 2
CleanFARMS Ontario Farmer Survey	BlackSheep Strategy	January 19 2011	Appendix 3
CleanFARMS Final Report Ontario Agricultural Waste Study – Waste Characterization	2cg Waste Management Consulting Services	May 2011	Appendix 4
Waste Characterization Survey of Animal Health Products Sold in Ontario by Members of the Canadian Animal Health Institute in 2010	Canadian Animal Health Institute CAHI-ICSA	March 3, 2011	Appendix 5
Ontario Agricultural Film Plastic Waste Characterization Study	BlackSheep Strategy	December 2010	

1.3. Phase II

This Phase II study is composed of four sections:

1. the risk assessment, which will include:
    a. identifying a list of materials to be assessed,
    b. an assessment of the enviro-impact of the selected materials based upon current practices and identify how end of life management can reduce potential impacts to water quality through proper collection and processing of targeted materials.
    c. developing recommendations for end-of-life management – employing the best approved methods for dealing with managing unwanted or spent plastics, paper fibre and animal health products materials.
2. collection options, which will include:
    a. a review of material volumes
    b. where to collect materials
    c. how to collect materials,
    d. how often to collect materials, and,
    e. a cost benefit analysis of the collection options
3. processing options, which will include:
    a. where the best available markets are located
    b. constraints on the processing of materials
    c. marketability of materials and market forces
    d. a cost benefit analysis of the processing options
4. stewardship options, which will include:
    a. identifying the best alternatives for establishing EPR solutions for materials which do not fall under stewardship regulations
    b. identifying how to structure a Stewardship program to address these materials

2. Risk Assessment

2.1. In-Scope Materials

At the beginning of the project it was agreed that the materials included in the study would be based upon a preliminary risk assessment and be categorized based upon common characteristics that would allow for meaningful, effective analysis and subsequently the design of a materials management program.

The following Table 2 - Material Waste Stream Profile illustrates the many on-farm generated waste materials that have been organized into distinct categories for analysis.

Table 2 – Material Waste Stream Profile

Waste Stream	Material Description	Province Wide Management System	Estimate Volume (in Tonnes)
Miscellaneous			
Pesticides	Chemical	YES	117
Engine and Hydraulic Oil	Oil	YES	not available
Sanitation Products	Chemical	NO	fully consumed
Plastic			
Film Plastic – incl. Silage/Bale Wrap	LDPE	NO	3,510
Woven Bag Plastic	PP	NO	490
Twine Products – incl. Net Wrap	PP	NO	1,227
Pesticide Jugs, Pails and Drums	HDPE	YES	275
Sanitation Products Jugs, Pails and Drums	HDPE	NO	1,115
Oil Plastic Jugs, Pails and Drums	HDPE	YES	360
Greenhouse and Nursery potted plant insets, trays pots etc.	PP, PS	NO	505
Potted Plant Sleeves	PP, LDPE, HDPE, PS	NO	60
Paper Fibre			
Kraft Paper Bags – unlined seed bags	Paper fibre	NO	400
Kraft Paper Bags – lined bags	Paper fibre and plastic	NO	240
Cardboard Boxes	Paper fibre	YES	4,780
Cardboard Boxes Waxed	Paper fibre, coated	NO	1,050

Table2 - continued

Animal Health Products			
Animal Medications	Pharmaceutical	NO	1
Glass Bottles	Glass	NO	1,097
Plastic Bottles	HDPE	NO	67
Sharps	Bio-haz	NO	9
Packaging - bags, plastic bottles, inserts, tubes, boxes	Mixed Stream	NO	20

A province wide management system includes recycling and diversion programs which are offered:

- in both urban and rural areas,
- at multiple venue categories including retail locations,
- at municipal sites,
- to residents at the curbside, and,
- are accessible and available to farm users within a reasonable distance.

These programs are typically steward funded and can be operated by both public and private organizations.

Material categorized in the miscellaneous category in Table 2 were not included in the following risk assessment for two reasons: first, there are existing province-wide programs in place to capture and properly recycle and dispose of these materials and secondly, in the case of Sanitation Products, there were no reportable wastes generated from the chemical usage.

In the case of pesticide containers, these materials were not included in the risk assessment as a result of the ongoing operation of a national collection program operated as the CleanFARMS Pesticide Container Management program. This program is run across Ontario with collection stations set up at a large number of pesticide dealer depots.

While a portion of the cardboard box volumes generated on farms may be captured through municipal curbside collection programs or by private contractors through on-farm collection services, there is a significant volume of these materials being generated across the province that have the potential for being disposed of in a less than optimal manner, such as through landfill, onsite burial or onsite burning. This alone justifies the inclusion of this waste stream in the risk assessment component of this study.

In terms of categorization for risk assessment purposes; three broad categories were identified which provided a basis upon which an understanding of environmental risk potential and scope of impact could be assessed. The categories are 1. plastics, 2. paper fibres and 3. animal health products.

Plastic volumes include a broad range of similar materials that share common environmental characteristics, similar chemical formulations and disposal practices. These materials are used as both inputs and outputs in the sectors of crop production and livestock production. For the purpose of this study, only output volumes are considered.

Paper fibre volumes include both Cardboard (OCC) based materials and paper based materials such as Kraft paper, lined and layered bags. While the recycling and processing procedures for these materials may be quite different, the net impacts and risks that they pose to the environment, and ultimately Great Lakes Water quality, through improper management, are relatively similar.

The animal health products were grouped together due to the commonalities of the products in terms of intended use, disposal considerations, and heterogeneous material composition. This category is composed of animal health products and their packaging, which have been limited to include:

- animal pharmaceuticals,
- biologics,
- animal pesticides, and,
- feed additives.
- packaging derived from the use of the materials – plastic, paper and other.

2.2. Great Lakes Basin Vulnerability

The health of the Great Lakes environment and consequently the water quality of the drainage basin and tributaries that feeds the Great Lakes has long been an area of concern to both the governments of Canada and the United States. Pursuant to this concern are the dependencies that the populations surrounding this area have on this resource, and those across North America. The Great Lakes Basin provides abundant potable water supplies for surrounding communities, irrigation for food crops, fisheries and transportation of natural resources and finished goods.

As a component of the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem and OMAFRA's Great Lakes Program a profile of agriculturally generated waste materials has been produced which have the potential to impact the water quality in this region.

Plastic farm waste, paper fibre based products and animal health products and packaging have the potential to negatively impact the quality of water entering the great lakes through a number of channels, which include:

- localized air to crop/livestock emissions from the open burning of waste materials,
- localized air to ground emissions from the open burning of waste materials,
- leachable pollutants from the on farm or off farm landfill disposal of materials, and,
- farm run off of contaminated waters from on farm burning or storage of waste.

Toxic contaminants pose a threat to aquatic species, wildlife and as the top of the food chain, humans also. While the long term effects of the levels of toxins within the food chain are under constant study and debate, what is not arguable is that human health will only be impacted negatively if the level of these materials continues to rise over time.

2.2.1. Chemicals of Emerging Concern

The International Joint Commission issued a report in 2009 as a component of the Great Lakes Water Quality Agreement Priorities 2007-2009 Series. The Work Group Report on Chemicals of Emerging Concern provided insight into the status of research in this area, and the direction in focus and approach

that was occurring in how the United States and Canada were jointly examining threats to water quality in the Great Lakes Basin. The report indicates that there has been a shift since the later 1990s from a focus and analysis of what are referred to as legacy pollutants to a broad range of new chemicals which are being discovered in the environment, and have come to be known as "chemicals of emerging concern". The working group report further comments that the term "chemicals of emerging concern" has been more commonly used to define "the emerging awareness of the presence in the environment of many chemicals used by society that are unregulated or inadequately regulated, along with concern over the risk that these chemicals pay pose to the health of humans and ecosystems." (IJC 2009).

The IJC acknowledges that there have been many improvements to Great Lakes water quality over the past twenty five years due to specific actions which have targeted many municipal, industrial and agricultural sources of contaminants, however, due to the potential of chemicals of emerging concerns to enter into the Great Lakes from multiple sources of generation, there has been a change in focus from reducing emissions from industrial processes to reducing emissions from the use and disposal of products.

The IJC Report identifies a number of sources of exposure to products which require further focus and attention, including:

- substances such as phthalates and perflourinated compounds which are commonly released during the use or disposal of products.
- contaminants entering the lakes through sewage treatment plants and overflows such as components of cosmetics, pharmaceuticals and possibly nano materials
- current use pesticides and agricultural products entering from runoff, and,
- end of life exposures such as toxic metals from landfills.

The IJC further states that the accumulation of these substances in the Great Lakes basin may be preventable by changing a number of practices including:

- use reduction
- removal of products from waste streams by improved technologies, and,
- reduction of toxicity and harmful physical properties of chemicals at the chemical and product design stage.

Consequently, it is imperative that the work of International Joint Commission, Binational Committees and federal and provincial stakeholder groups continue to identify areas and materials of concern, establish causality and identify methods and solutions to interrupt and prevent these ongoing environmental impacts. ***The Ontario Agricultural Waste Management Study – Phase II: Risk Assessment, Collection, Processing and Stewardship Options***, under the auspices of the Canada-Ontario Agreement Respecting the Great Lakes Basin, seeks to further the work being done to improve the Great Lakes Water quality through the identification of agriculturally utilized products, the risks they pose to the environment and make recommendations on sustainable systems which can be implemented for the end-of-life management of these materials.

Figure 1 illustrates the broad drainage area included within the Great Lakes basin. It is clear that pollutants entering the watershed area in Southern Ontario are destined to end up travelling through the air, runoff water and leachate channels into the Great Lakes water system.

Figure 1 – The Great Lakes Drainage Basin

2.3. Plastics

Plastics waste, as generated on agricultural sites, include substantial volumes of the following materials:

- Low Density Poly Ethylene (**LDPE**) and Linear Low Density Poly Ethylene (**LLDPE**),
- High Density Polyethylene (**HDPE**),
- Polypropylene (**PP**), and,
- Polystyrene (**PS**).

In 2010, during the Phase I portion of this research project, a characterization of agricultural plastic waste conservatively estimated the volumes of plastic available for recycling in Ontario. Table 2 provides a detailed breakdown of the different sources and types of plastic available, and is summarized in Table 3 as follows:

Table 3 – Agricultural Plastic Availability by Type

Plastic Type	Products	Estimated Annual Available Volume
LDPE and LLDPE	• bale wrap, silage wrap, greenhouse film, mulch film, fertilizer and grow bags	3,510 tonnes
HDPE	• jugs, pails and drums	1,182 tonnes*
PP	• twine, net wrap, woven plastic bags, greenhouse pots and trays	1,717 tonnes
PS (some PP mixed)	• pots, trays, cell trays, sleeves	565 tonnes
Total Available		6,974 tonnes

* HDPE estimates include a 67 tonne volume of containers from animal health products packaging.

2.3.1. Plastic – End of Life Management

In January 2011, BlackSheep Strategy Inc. undertook a study of Ontario farm plastic waste generation, including disposal practices and attitudes. It was found that plastic waste was being generated across most agricultural segments and included the following waste materials in Figure 2. These materials have been ranked by the percentages of generators surveyed, who produced one or more of these different waste streams.

Figure 2: Types and Frequency of Farm Generated Plastic Waste

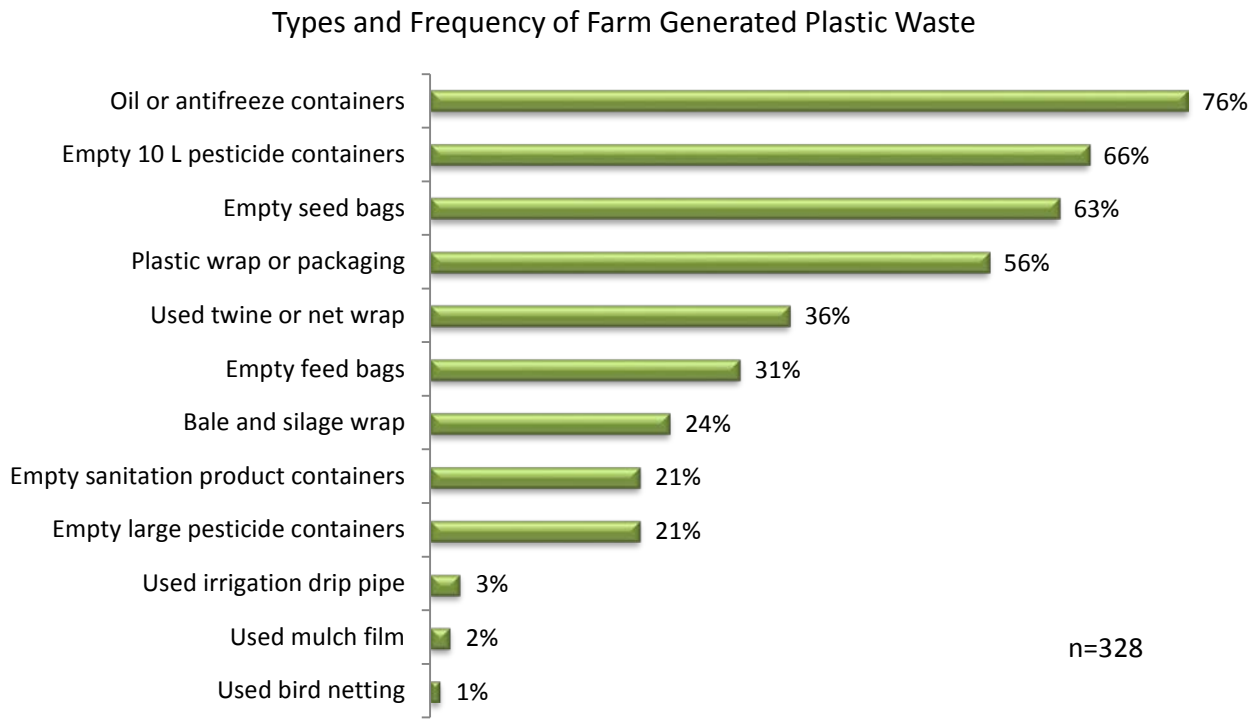
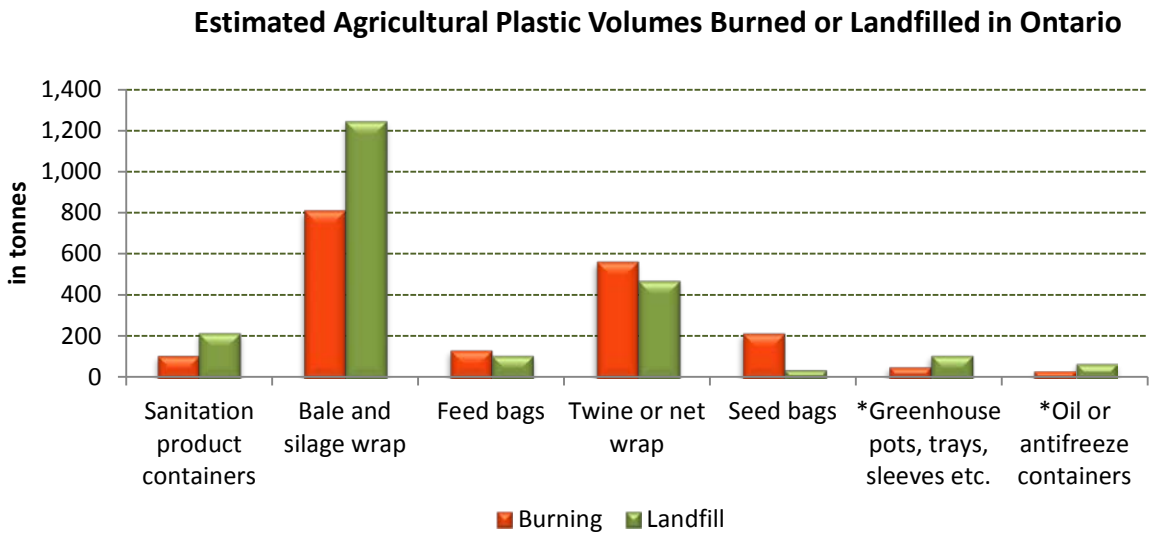


Figure 3 below reflects an estimate of the volume of agricultural plastics which are burned on an annual basis in Ontario. These figures were calculated using the BlackSheep Strategy landfill and burning practices data and by cross referencing that information with the estimated volumes quantified in the Ontario Agricultural Waste Study – Waste Characterization by 2cg Waste Management Consulting Services.

The estimated amount of agricultural plastics disposed of in Ontario through burning is approximately 1,938 tonnes with approximately 2,292 tonnes being landfilled. This represents 58.2% or 4,229 tonnes of an estimated 7,267 tonnes of available agricultural plastic which are disposed of through these processes. The heavy reliance on these disposal practices provides for a significant opportunity for diverting large volumes of waste to more environmentally friendly alternatives. This positive shift in disposal processes will directly result in immediate benefits to the environment, and indirectly to the water quality of the Great Lakes Basin.

Figure 3 - Estimated Agricultural Plastic Volumes Burned or Landfilled in Ontario



* denotes material handling method from like material streams

Figure 3 clearly indicates those waste streams that should be targeted for diversion programs on a priority basis, specifically bale wrap and silage wrap, and, twine and net wrap.

Volume estimates from previous studies have been included in the analysis for burn and landfill rates for managing greenhouse plastic containers (pots, trays and sleeves) and oil and antifreeze containers. For the purpose of determining these burn and landfill 'percentage' values, the "sanitation product" container rates have been applied as a conservative indicator of likely disposal practices.

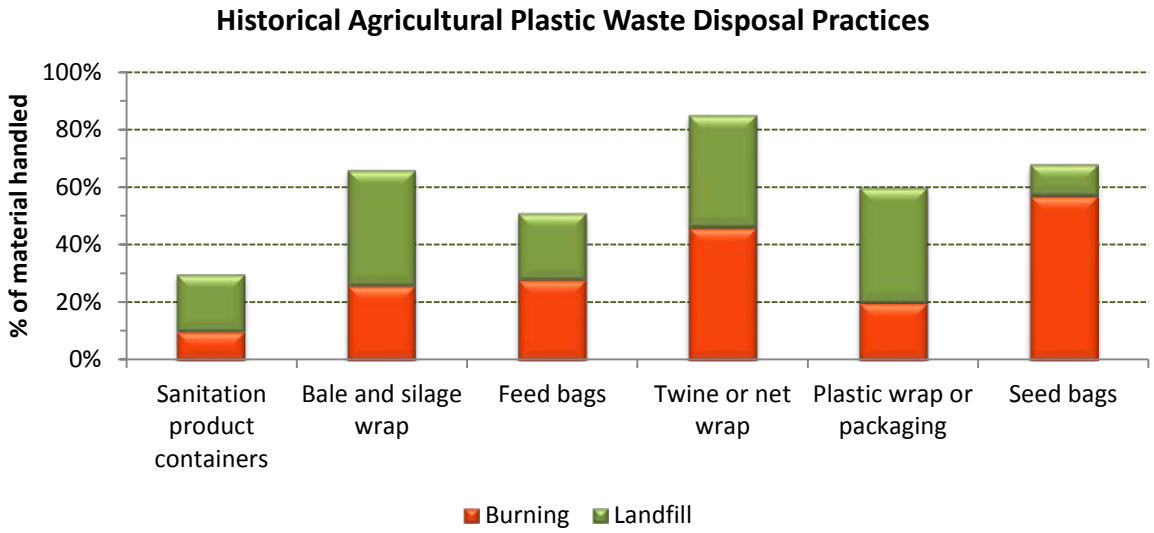
Table 4 – Plastic Burning and Landfill Volume Estimates provides a detailed breakdown of the volumes of plastic sent for less than optimal disposal in Ontario.

Table 4 – Plastics Burning and Landfill Volume Estimates

Burning	Landfill	Material	Burning (tonnes)	Landfill (tonnes)	Total (tonnes)
10%	20%	Sanitation product containers	112	223	1,115
26%	40%	Bale and silage wrap	813	1250	3,125
28%	23%	Feed bags	137	113	490
46%	39%	Twine or net wrap	564	479	1,227
57%	11%	Seed bags	219	42	385
*10%	*20%	Greenhouse pots, trays, sleeves etc.	57	113	565
*10%	*20%	Oil or antifreeze containers	36	72	360
		* denotes estimated %	1,938	2,292	7,267

Figure 4 below, illustrates the particular plastic waste streams that most heavily rely on burning and landfill for disposal. Together with the material volume estimates, this chart clearly supports the top three waste streams of twine products, bale wrap products, and seed bags as areas of concern and opportunity.

Figure 4 - Historical Agricultural Plastic Waste Disposal Practices



Seed bags are of particular concern when examining end of life management options. These seed bags potentially contain pesticide contamination which makes them unsuitable for recycling through currently available means. Furthermore, current handling methods would require either washing prior to handling or destruction through high temperature incineration. The potentially contaminated nature of seed bags further makes the collection and handling of these wastes a regulated process under the Ontario EPA and Ontario Regulation 347, waste management guidelines. Consequently, these bags would be required to be managed and treated similarly to obsolete pesticides and would require a similar type of destruction. While it is possible to recycle contaminated plastic, a readily available processor is not currently online or cost effectively accessible for film and fibre bags.

Open burning of seed bags produces the added impact of not only releasing the pollutants from low temperature plastic incineration into the air and surrounding soil and waterways, but also releases many other contaminants including dioxins, furans, volatile organic compounds VOCs, semi VOCs, particulate matter (PM10), and polycyclic aromatic hydrocarbons (PAHs). It is commonly accepted that the low temperature burning of pesticide contaminated plastic is a particularly dangerous and harmful disposal method.

2.3.2. Environmental Impacts of Improperly Managing Plastic

In July 2011, a review of the impact of the open burning of agricultural plastic on the environment was prepared by Sonnevara International Corp. and entitled Ontario Agricultural Study: Environmental Impacts of Open-Burning Agricultural Plastics. The following provides a summary of the findings of that report and is taken directly from the Executive Summary.

In their daily activities, farmers use a variety of plastics, including baler twine, silage wrap, grain bags and pesticide containers. Use of agricultural plastics is increasing, as applications such as large plastic grain bags for on-field storage are becoming more commonplace. A comprehensive program operated by CleanFARMS exists nationally to manage waste pesticide containers, and farmers have easy access to this program to dispose of their used pesticide containers. However, no similar program exists for other farm plastics, and these materials present a serious disposal issue to farmers across Canada.

Farmers typically have four options when it comes time to manage their plastic waste:

- on-farm open burning,
- on-farm burial,
- transport to a municipal landfill site for burial, and,
- transport to a public or private location for recycling.

The recycling of plastics results in a net reduction of a host of harmful emissions and also reduces the consumption of non-renewable resources. This generally means that recycling results in the largest net environmental benefits for most agricultural plastic products.

The challenge then becomes developing access to recycling facilities for agricultural plastics which is limited in most locations. In addition, disposal of agricultural plastics at municipal landfill sites is restricted in some areas.

Therefore, while most farmers make efforts to be good environmental stewards, open burning of waste plastics on farms remains a common practice. This presents both air pollution and resource conservation concerns. Even though releases of dioxins and furans in Ontario from open burning represents less than 2% of the provincial total, the release of these chemicals is being done on agricultural land. This places the health of human, animals and the environment particularly at risk, given the significant bio-accumulative nature of the pollutants. Dioxins and furans have been detected in Lake Ontario tributaries and are routinely found in higher levels in the Niagara River. (Human Health and the Great Lakes, 2003).

Sonnevara states that open burning of agricultural plastics can lead to the release of many air pollutants and hazardous by-products, including heavy metals, dioxins and furans. Furthermore, on-site burning of household garbage (such as burning barrels) has been identified as the largest source of dioxin emissions in Ontario. Dioxins and furans are a health concern even in very small quantities, being associated with endocrine disruption, heart disease, cognitive and motor disabilities, as well as being a known human carcinogen.

The burning of plastic agricultural plastics is of particular concern to the Great Lakes Basin Watershed - home to 95 percent of the surface water in North America along with 21 percent of the world's surface freshwater - where dioxins and furans pose a serious threat to aquatic species, wildlife, soil fertility, and humans. Dioxins and furans are also considered a Tier 1 pollutant by the Canada-Ontario Agreement Respecting Great Lakes Basin Ecosystem. Being a Tier 1 pollutant suggests the pollutant is a persistent bioaccumulative toxic substance. It is through the "Harmful Pollutants" annex that Canada and Ontario

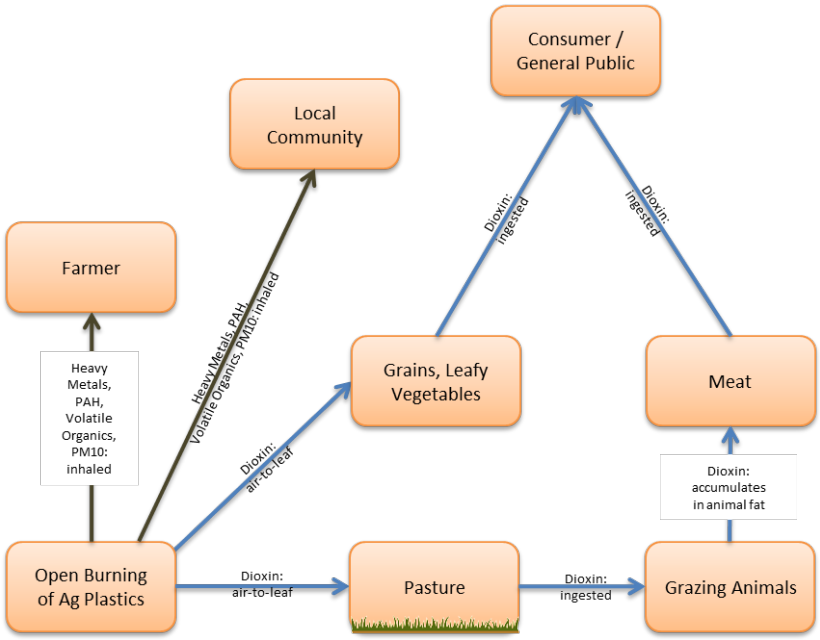
have agreed it is important to eliminate all sources of Tier 1 pollutants. Consequently, this would require all burning of plastic agricultural waste to be suspended.

It should be noted that the significant impact of bio accumulative pollutants are their ability to remain resident in the environment, the food chain and humans and animals. The effects of Tier 1 pollutants increase over time as their concentration in the environment grows. This further reinforces the critical need to change the way in which plastics are managed and to mandate change at the primary level, the user.

Of particular concern to farmers and those living within the Great Lakes Basin is that exposure to these pollutants can occur through direct inhalation or ingestion of contaminated plants or animals. Given the reliance of the agricultural community within Ontario upon the tributarial water flow and the dedicated resource which the Great Lakes provides, any reduction in airborne and leachable pollutants is of immense benefit to the water quality, in both the immediate and longer term.

Figure 5: Pathways of Exposure to Pollutants from Burning Ag Plastics illustrates the typical pathways of plastic generated pollutants from the point source of the emissions to the point of human impact.

Figure 5: Pathways of Exposure to Pollutants from Burning Ag Plastics



2.3.3. Environmental Impacts of Open Burning of Plastics

One of the fundamental concerns of burning agricultural plastics is that they burn easily but incompletely in an open burning scenario. Incomplete combustion can lead to the release of carbon monoxide as well as many other air pollutants.

Probably the emissions of greatest concern during open burning of agricultural plastics are dioxins and furans, which are most commonly formed in instances of low combustion temperatures, such as those associated with open burning. The dioxins and furans that are released during the incomplete

combustion of plastic products pose a serious threat to aquatic species, wildlife, soil fertility, and humans (Krantzberg et al, 2006). In addition, hazardous by-products can be present in the residual ash and in airborne emissions in the form of heavy metals, and further amounts of dioxins and furans

At temperatures below 750°C, significant pyrolytic degradation of polyethylene (PE) occurs, however, complete combustion would not occur. PE melts and thermally degrades at relatively low temperatures (105 and 180°C). At temperatures below 750°C, as much as 18 to 41 percent of the mass of PE is lost and volatilized prior to particle ignition. Additionally, emissions from this early phase of the pile burn would contain a high percentage of aliphatic hydrocarbons and radicals, as well as a low percentage of aromatic and polycyclic aromatic hydrocarbons (PAHs). By the time the burn pile temperature becomes hot enough to combust the PE, most, if not all of the PE would have already been pyrolyzed and lost to the atmosphere (Wrobel and Reinhardt, 2003) .

For additional information on incomplete combustion of plastics during low temperature burning please see the full 2011 report entitled Ontario Agricultural Study: Environmental Impacts of Open-Burning Agricultural Plastics by Sonnevara International Corp.. A brief summary of the Sonnevara emissions results are summarized, as follows:

Survey of Common Emissions from the Open Burning of Plastic

- **Benzene** – effects of exposure range from anemia to cancer.
- **Carbon Monoxide** – excessive exposure to this chemical inhibits oxygen transport in the blood
- **Dioxins** – dioxins disrupt multiple endocrine pathways, increase the risk for ischemic heart disease, cognitive and motor disabilities, and endometriosis. Dioxins are also known carcinogen.
- **Ethylbenzene** – this chemical damages the inner ear and hearing, produces kidney damage in animals, and is a possible human carcinogen
- **Particulates** – these pollutants increase the risk of stroke, present a greater danger to human health than present levels of other common air pollutants such as ozone, sulfur dioxides and carbon monoxide, and are connected to premature deaths from respiratory and heart disease
- **Polycyclic Aromatic Hydrocarbons (PAHs)**: several of these chemicals cause tumors from inhalation, skin contact and ingestion. Associated with reproductive and immune system issues, these pollutants are considered possible carcinogens.
- **Sulfur Dioxide** - sulfur dioxide produces irritation of the upper respiratory tract, eye irritation and shortness of breath
- **Toluene** – this industrial solvent promotes neurotoxicity effects as a result of exposure.

In the 2011 report, Sonnevara asserts that recycling the agricultural plastics that are used annually in Ontario would represent a net greenhouse gas savings of more than 20,000 tonnes of CO2 equivalent, or result in the same impact as removing more than 4,000 vehicles from the road for a year.

Sonnevara further concludes that there is a strong national need to develop a comprehensive stewardship program for waste agricultural plastics to address the lack of adequate management systems for these waste products and the potential environmental impacts associated with improper disposal.

Landfill is not an optimal method for managing farm produced plastic waste streams. While studies involving the environmental impacts of on-farm and offsite landfilling of plastic waste are not readily available, there are obvious consequences to landfill as a disposal practice, namely the missed opportunity in recovering a valuable commodity in terms of resource conservation, and also the challenge of the resilient nature of plastic within the context of bio degradation.

The production of plastic is a resource and energy intensive process which occupies a significant carbon footprint. By landfilling this easily convertible resource, industry loses the opportunity to bypass a significant phase of the resin production component of the manufacturing process. Recycling plastic instead of landfilling contributes to a reduction in the production of greenhouses gasses and in the net use of energy when compared to virgin resin production.

A key factor in the landfilling of plastic waste is the sequestration of carbon dioxide and other greenhouse gasses, since plastic does not degrade or breakdown significantly over time. Landfills effectively promote the sequestration of greenhouse gasses in plastic products and prevent their escape to the atmosphere or groundwater. While this may appear to be a net positive characteristic of plastic, this sequestration does not offset the pollution and carbon footprint generated from the manufacture of virgin resin. Hence the net pollution emissions from utilizing landfills in comparison to the recycling of plastic are higher.

2.4. Paper Fibre

In 2010, during the Phase I portion of this research project, a characterization of agricultural paper fibre waste conservatively estimated the volumes of paper fibre from agricultural use which is available for recycling on farms in Ontario. Table 2 has provided a detailed breakdown of the different sources and types of paper fibre waste available, and can be summarized by fibre type, in Table 5 as follows:

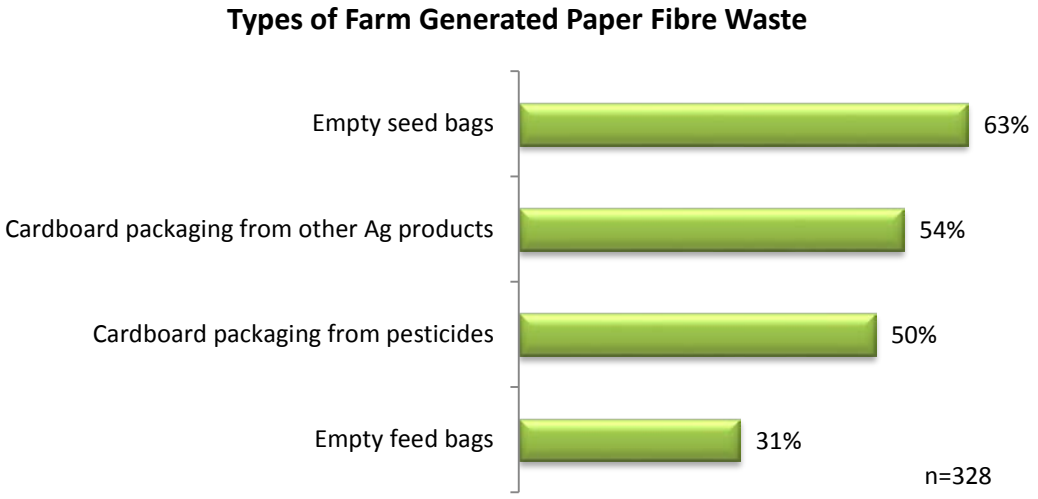
Table 5 – Agricultural Paper Fibre Availability by Type

Paper Fibre Type	Products	Estimated Annual Available Volume
Paper fibre	Unlined Kraft Paper Bags (Seed)	400 tonnes
Paper fibre and plastic	Lined Kraft Paper Bags (Feed)	240 tonnes
Cardboard paper fibre	Cardboard Boxes	4,780 tonnes
Cardboard paper fibre, coated	Cardboard Boxes Waxed	1,050 tonnes
Total Available		6,470 tonnes

2.4.1. Paper Fibre – End of Life Management

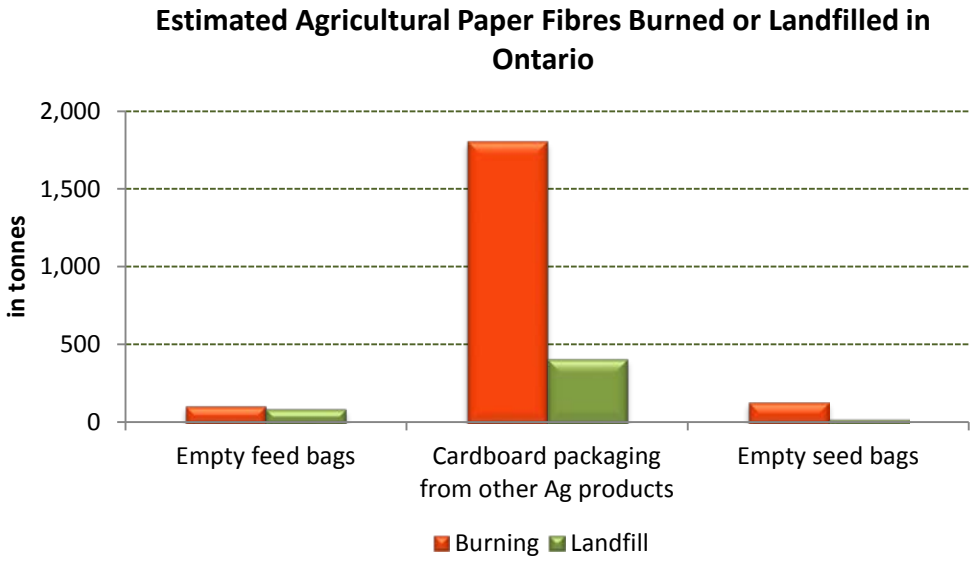
In January 2011, BlackSheep Strategy Inc. undertook a study of Ontario farm generated paper fibre waste disposal practices and attitudes. It was found that paper fibre waste was being generated across most agricultural categories. Figure 6 describes the following waste materials generated and ranks them by generator frequency.

Figure 6: Types and Frequency of Farm Generated Paper Fibre Waste



Cardboard volume from pesticide products is not specified in the BlackSheep report. This material has been designated as a non-recyclable as a result of the potential for pesticide contamination, and must be treated as a potentially hazardous material. Consequently, it has not been considered in recyclable material volume calculations.

Figure 7 - Estimated Agricultural Paper Fibres Burned or Landfilled in Ontario



The estimated volumes of recyclable waste paper fibre generated on Ontario farms as illustrated in Figure 7 provide a strong indication on where attention and focus need to be placed in order to efficiently promote diversion and recycling of agricultural paper fibre waste and to achieve the greatest potential for making a significant and timely, positive environmental impact. Table 6 provides a further indication as to the total volume of paper fibre category waste burned or landfilled in Ontario

Table 6 – Paper Fibre Landfill and Burning Volume Estimates

Burning	Landfill	Material	Burning (tonnes)	Landfill (tonnes)	Total
28%	23%	Empty feed bags	112	92	204
31%	7%	Cardboard packaging from other Ag products	1,807	408	2,215
57%	11%	Empty seed bags	137	26	163
			2,056	527	2,583

A significant characteristic which impacts potential paper fibre recovered volumes is the difference in opportunities for recycling that exist for cardboard and paper materials as compared to other streams such as plastic and animal health products. The recycling market for Cardboard (OCC) and fibre has been in existence for many years, has many commonly available processors and has reached a mature stage of development. Plastic recyclers have been slower in developing and have focused on a much

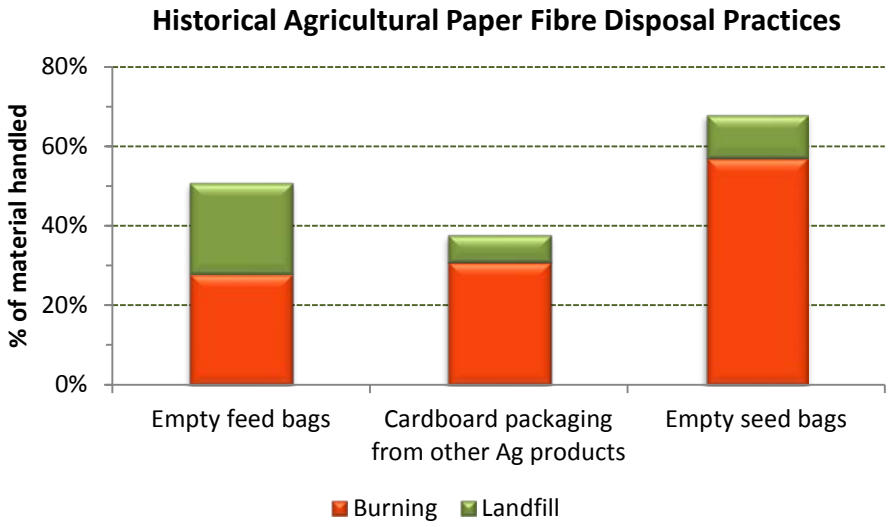
narrower segment of products, such as those materials supplied by the Blue Box curbside collection program in Ontario.

Figure 8 – Historical Material Disposal Practices reveals that farmers have traditionally relied more upon landfill or burning for disposal of feed bag and seed bag wastes, than for cardboard (OCC) materials. This is likely due to the greater recycling opportunities which exist for common paper fibre materials such as OCC. This is supported by the lower than average (38%) reliance on burning and landfill to manage the OCC materials.

It should also be noted that the use of landfill or burning for cardboard materials is also strongly linked to the high volumes of waxed OCC cartons used in the province, as there are no recyclers of this material readily available or who can be cost effectively accessed by the Ontario market.

Correspondingly, items such as laminated or lined paper bags which are not acceptable by most conventional recyclers reflect a burning and landfill practice between 51% and 68% respectively.

Figure 8 –Historical Agricultural Paper Fibre Disposal Practices



2.5. The Impact of End of Life Management Practices

In July 2011, a study commissioned under the Phase II research component of this project was initiated to develop a better understanding of the environmental impacts that could be realized by abandoning the traditional disposal practices of burning and landfilling recyclable agricultural plastic and paper fibre products and instead choosing recycling options. This study, **Ontario Agricultural Waste Study: Measuring the Environmental Benefits of Recycling Agricultural Wastes** – CM Consulting Inc., was able to capture the net consumption of all three processes in terms of energy usage (in Gigajoules, Gj) and also greenhouse gas emission (CO2e) contributions.

In Canada, in the absence of a moratorium on landfilling and burning recyclable agricultural packaging materials made from plastic and paper fibre, a significant amount of these materials are landfilled or burned annually. Open pile burning (pile or forced air) poses a series of health and safety hazards, which include air pollution, impacts on groundwater and soil contamination from ash disposal, and fire hazards.

Landfill and burning also produce a net loss of energy because the material was not recycled. Making products from recycled raw material requires much less energy than virgin resources because of the avoidance of all of the primary extraction functions for the raw materials. In terms of plastics like HDPE, PP and LDPE, recycling avoids the need to extract and process crude oil and natural gas, produce Olefins and polymerize.

In the case of paper-based packaging, manufacturing corrugated packaging with old cartons eliminates the need to harvest roundwood and wood residual production, the mining of sodium and sulfate, the production of soda ash, or the manufacture of corn starch. Avoiding roundwood harvesting also has the added benefit of maintaining carbon sequestration, which further contributes to an overall positive impact on greenhouse gas (GHG) emissions reduction.

Using Life Cycle Analysis (LCA) models available from Environment Canada, the “net benefit” of end-of-life management options for waste can be measured. In the case of agricultural wastes, like plastic film, twine, bale wrap, drums and pails; paper bags and corrugated boxes, the benefits of recycling instead of disposal (landfill or thermal treatment) are significant.

Specifically:

- Recycling paper and plastic-based agricultural wastes avoids from 1.8 to 3.26 tonnes of greenhouse gas emissions (CO2e) per tonne of paper and plastic based agricultural wastes recycled respectively;
- Disposing paper and plastic-based agricultural wastes in a landfill (with methane capture for flaring) creates from 0.01 tonnes of GHG emissions (CO2e) from plastics to 1.2 tonnes of GHG emissions per tonne of paper landfilled;
- Disposing of plastic-based agricultural wastes through thermal treatment (with electricity production) creates nearly three tonnes of greenhouse gas emissions (CO2e) per tonne of plastic;

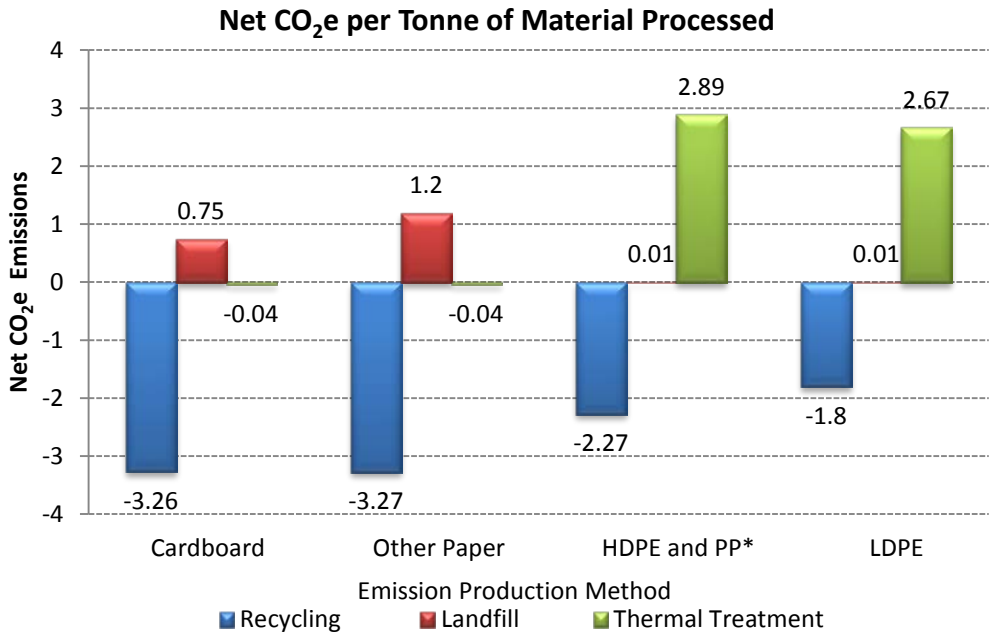
- Recycling paper and plastic-based agricultural wastes conserves considerably more energy than landfilling and thermal treatment. Specifically, three times more for cardboard; more than 4 times more for paper, and greater than 10 times more energy conserved when recycling plastics instead of thermal treatment, and even greater amounts compared with traditional landfilling (with methane flaring).

These recycling benefits are measured against more traditional waste management options, like landfill and thermal treatment (or incineration) which burns materials in a controlled environment, allowing the facility to manage emissions. However, today a significant amount of farm waste is buried or burned on-site. Environment Canada suggests that "barrel burning" (burning garbage on-site without controlled conditions and pollution prevention) may be the largest remaining single source of anthropogenic dioxins. Burning garbage on-site releases thousands more dioxins and furans than burning the same amount of waste in a municipal incinerator.

Unfortunately, data for many of the emissions that directly impact human health, like dioxins and furans; fine particulate matter (PM); heavy and metals are not readily available and highly dependent on individual system parameters (burn temperature; material burned; air flow etc.) and consequently are not predictably quantifiable.

Figure 9 - Net CO2e per Tonne of Material Processed illustrates the greenhouse gas emissions (CO2e) per tonne of paper fibre and plastic based agricultural wastes from the various processes of recycling, landfilling and utilizing thermal treatment (incineration). It is clearly visible that recycling provides the greatest net CO2e per tonne of material reduction, for all material streams, when compared against landfill and incineration.

Figure 9 - Net CO2e per Tonne of Material Processed

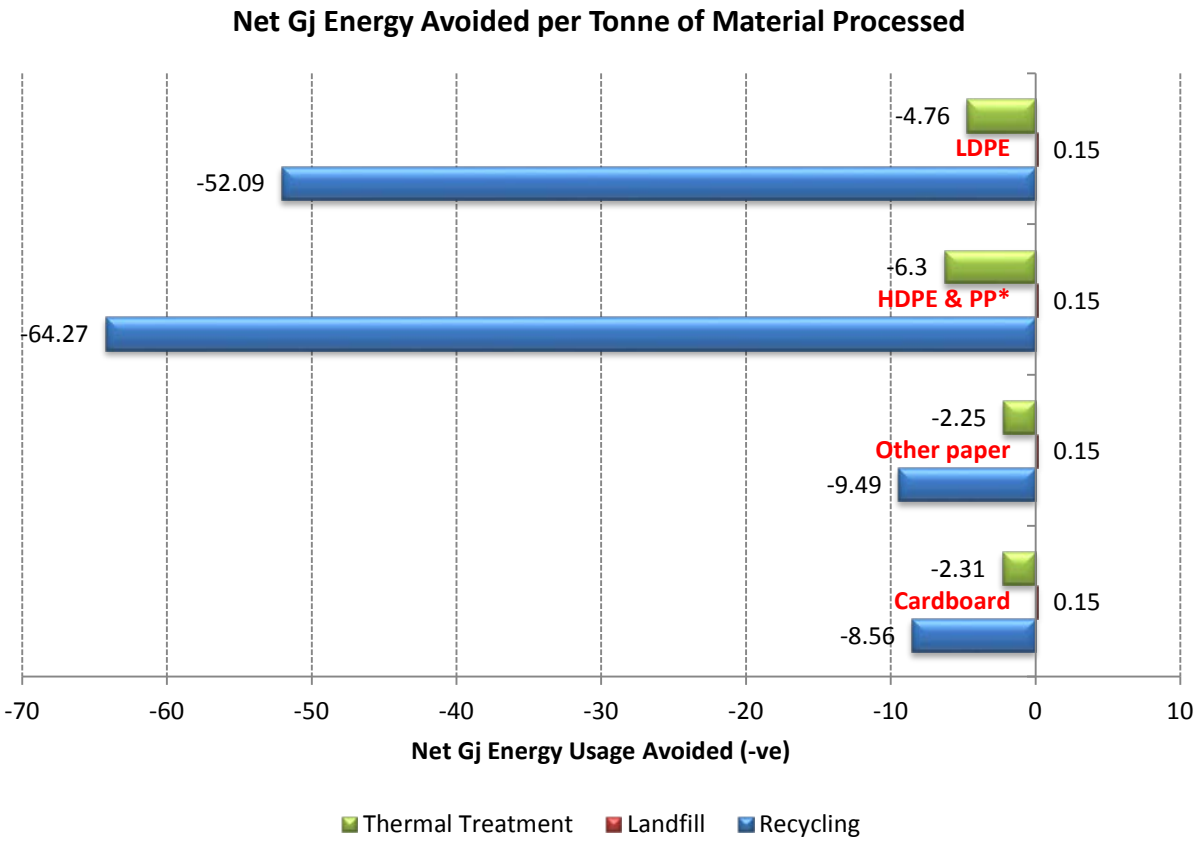


* Note: negative emissions are Net CO2e savings in material production lifecycle

When a life cycle analysis model is used to evaluate energy usage of the different end of life management approaches for paper fibre and plastic wastes, the significant contribution of recycling to energy avoidance is clearly evident. The life cycle analysis includes a number of different inputs and reflects energy avoided by reintroducing recovered material back into the manufacture of virgin product, the energy recovered through co-generation activities for incineration and also the energy required to operate and bury material in a landfill, which employs a landfill gas reclamation system. This model, although adapted from a US EPA model, reflect Canadian inputs such as energy costs and the corresponding difference in carbon footprints of these inputs.

Figure 10 - Net Gj Energy Avoided per Tonne of Material Processed demonstrates the high recycling value of capturing manufactured plastics and supplementing the use of virgin plastic in the production process with these materials. The recycling of paper fibre materials also demonstrates a high contribution to energy avoidance though significantly less than the plastics streams.

Figure 10 - Net Gj Energy Avoided per Tonne of Material Processed



2.5.1. Environmental Equivalency Benefits of Recycling

Based upon the positive effect of diverting all of the agricultural recyclable plastic and paper fibre from landfill and burning, significant environmental benefits could be realized.

Recycling the estimated 13,377 tonnes of plastic and paper fibre wastes generated annually on Ontario farms is predicted to yield the following equivalent benefits and savings:

- **7,919** – the pollution savings of removing an equivalent number of cars from the road for a one year period
- **4,348** – the number of Canadian individuals energy usage for a one year period
- **13,248,641** – the equivalent litres of gasoline saved based upon the energy value
- **75,270** – the number of barrels of oil saved by recycling
- **$8,032,045** – the value of oil saved by recycling (based upon March 14, 2012 price of a barrel of oil at $106.71 US)

These benefits are available in greater detail in the Appendix of the 2011 study **Ontario Agricultural Waste Study: Measuring the Environmental Benefits of Recycling Agricultural Wastes** – CM Consulting Inc..

ENERGY	Source for avoided energy multipliers: D*etermination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2005 Update Final Report*, ICF Consulting, Environment Canada & Natural Resources Canada, October 2005.
GHG	Source for avoided emission multipliers: D*etermination of the Impact of Waste Management Activities on Greenhouse Gas Emissions: 2009 Update (in excel input model)* ICF Consulting, Environment Canada & Natural Resources Canada, October 2005.

2.6. Animal Health Products

BlackSheep Strategy reports, in their August 2011 agricultural waste characterization study, that approximately 31% of farmers in Ontario generate some form of sharps or needles from their farm operations and approximately 19% of farms generate obsolete or unwanted animal health product waste. The March 2011 Canadian Animal Health Institute (CAHI-ICSA) report provides greater detail on individual packaging wastes from the broader animal health product category (see Appendix 5).

While this category is comprised predominantly of used glass bottles and packaging, the following table breaks down the estimated volume in detail (in tonnes).

Table 7 – Animal Health Product Packaging Category Details

Boxboard Cartons	Inserts	Glass Bottles	Plastic Bottles	Foil Bags	Tubes
8	1	1,097	67	1	2

The large volume of glass which composes this category supports the accuracy of the landfill usage estimate, as opposed to burning, as farmers would not expect to see significant volume reductions in waste as a result of burning glass.

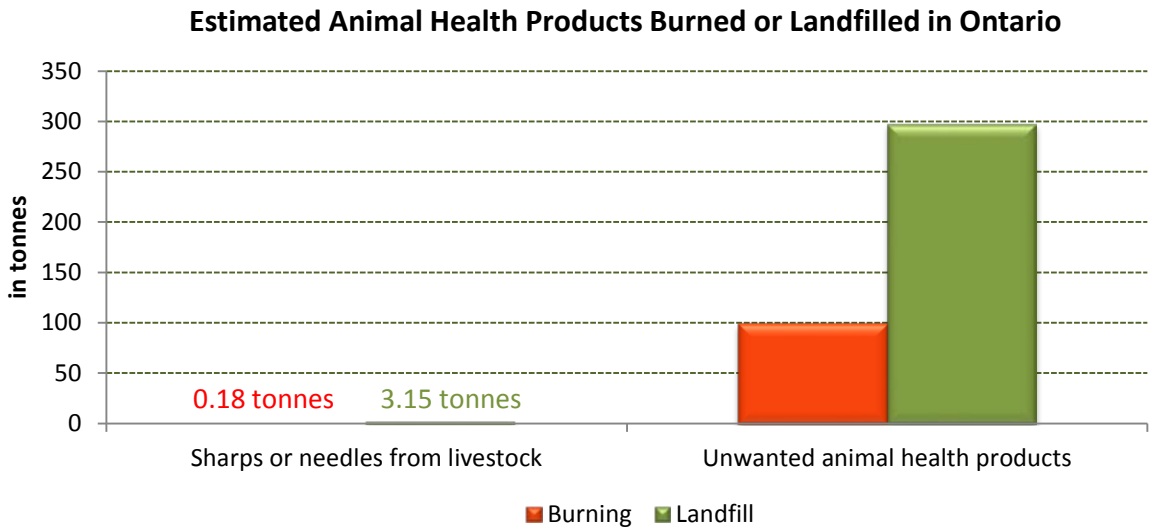
Furthermore, Table 8 provides similar validation of the greater reliance of farmers on landfills rather than burning, for materials in this category, as needles and sharps would provide no significant volume reduction after burning rather than by being sequestered in a landfill, either on farm or at a local municipal facility.

Table 8 – Animal Health Products Landfill and Burning Volume Estimates

Burning	Landfill	Material	Burning	Landfill	Total Tonnes
2%	35%	Sharps or needles from livestock	< 1 tonne	3	3
9%	27%	Unwanted animal health products	99	298	397
			99	301	400

In order to properly understand the relative impact of burning and landfilling of sharps, needles and animal health products, we must first understand the volumes of these materials in relation to each other, the material composition and the rest of the waste streams in this study. Figure 8 provides a solid indication of the relative volumes and impact that on-farm burning has on these particular waste streams. In total, in Ontario, it is estimated that only 180 KG of sharps or needles from livestock use are burned annually on farms. This is likely the function of a number of different forces which include the effective enforcement and regulatory framework put in place by the Ministry of the Environment, the tendency for veterinarians to remove sharps and related products once they have finished utilizing them on the farm, and the ability of farmers to return unwanted or spent materials to the point of purchase.

Figure 11 - Estimated Animal Health Products Burned or Landfilled in Ontario.



Farmer practices for managing animal health products, as documented by Strategic Research Associates for the eBiz January 2010 report, are supported in the BlackSheep Strategy study of January 2011. Both of these studies indicate that approximately 32%-35% of farmers return the animal health products to a veterinarian directly or to a retailer for disposal. Both studies also indicate that disposal on the farm occurs in the range of 8%-10.8% of farms.

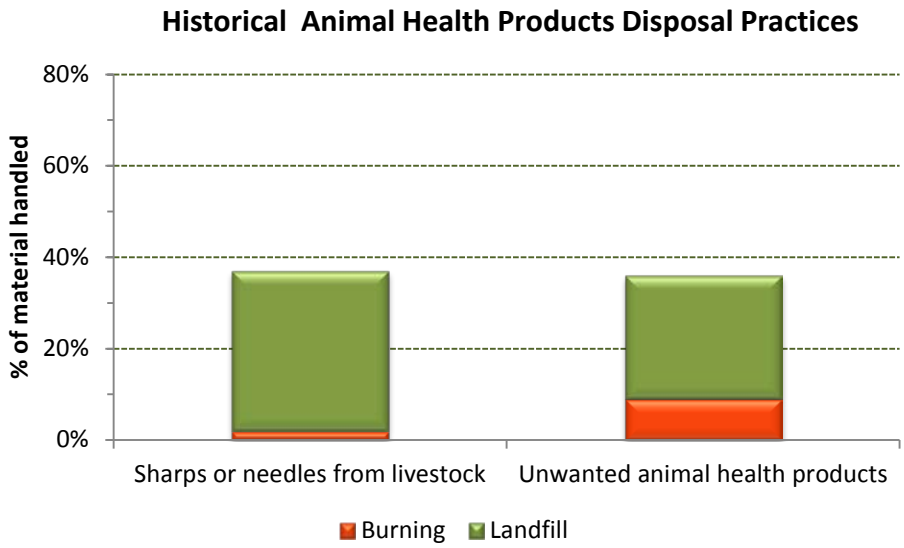
It should be noted that in the eBiz report, a survey of farmers' opinions about animal medicines was performed and the results indicated that 98.2% of farmers agreed that the collection, storage, and disposal of animal medicines is an important part of how they manage their farm. 97.4% of these same farmers also agree that preventing the release of animal medicines into water resources near farms is as important as preventing the release of manure, gasoline or excessive sediment.

The pervasiveness of these beliefs supports the medicine management behaviours of farmers, as described by CAHI, which is that, as a result of the small margins in agriculture, farmers tend only to buy the amounts of medicines that they require and, typically, will keep what is not used immediately for later usage. Additionally, CAHI reports that only a limited amount of unwanted animal medicines are believed to be in storage in Ontario.

The same report also indicates that 63.6% of famers believe they are doing all they can to dispose of animal medicines safely, while 34.6% of respondents believe a little more could be done to improve on disposal practices. In total, 98.2% of farmers surveyed believe that there is little or nothing additional they can do to improve their current disposal practices.

BlackSheep Strategy further indicates, as per Figure 12 below, that up to 37% of sharps and needles from livestock are still managed through either burning or landfill and that these options are only slightly less at 36% for unwanted animal health products.

Figure 12 - Historical Animal Health Products Disposal Practices



2.6.1. Animal Health Product Impact on the Environment

A number of international research groups are beginning to take a closer look at the link between medicines and the environment. The International Joint Commission (IJC) in its 2009 report included veterinary drugs in the working definition of "chemicals of emerging concern". It also included the characteristics of chemicals which are 'persistent' or 'bioaccumulative' or toxic, which may include a number of different types of veterinary pharmaceuticals and related products.

The report stated that detectable concentrations of pharmaceutical compounds were present in 34% of the surface water samples, and included prescription and non-prescription drugs. Of particular interest is that these readings were most frequently located in close proximity to waste water treatment facilities or near agricultural operations. The challenge identified in understanding and interpreting this data is that there were no standards, guidelines or criteria to use as a benchmark or comparator. (IJC 2009)

Further to the concerns outlined in the IJC report, there is also limited information on the cumulative exposure of these materials on human health and the ecosystem, including bio concentration via different pathways and the compounded interaction of different pharmaceuticals and biological medications in the natural environment. An EU study published in 2010 investigated the interactions of different bacteria in the environment. This study by Broshe and Backhaus indicated that, at its current levels, chlortetracycline, a commonly used antibiotic, is toxic to freshwater bacteria. However, when combined with four other antibiotics, the collective effect, of these antibiotics, are far greater than the individual effects.

Research performed in the European Union suggests a number of different pathways of veterinary medicines entering the environment. While the inappropriate disposal of used containers and unused medicines is not suggested to be the highest impact pathway of these materials to the ecosystem, it is one of the easiest pathways to interrupt.

Figure 13 – Pathways into the Environment for Veterinary Medicines (Boxall and Kolpin 2003)

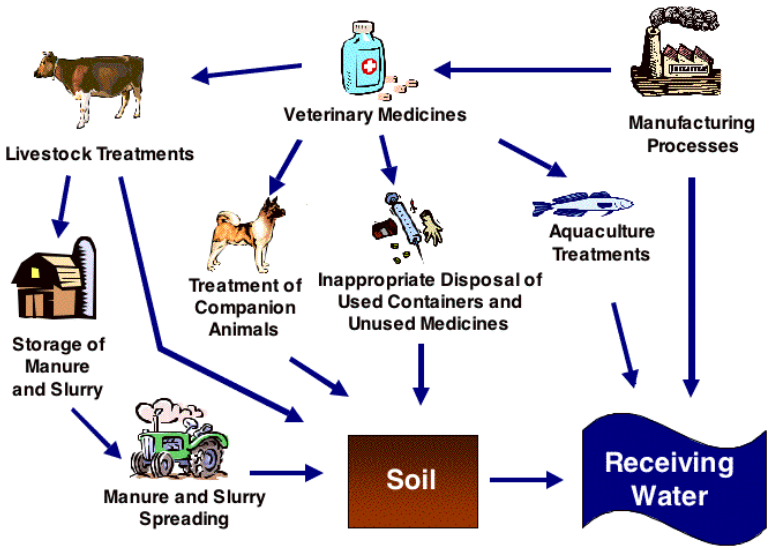


Figure 13 provides an indication of some of the different pathways of veterinary medicines may take to the environment. Researchers have yet to develop a comprehensive understanding of the interaction of different medicines together and also between other chemicals. For example a study in US streams found lincomycin (an agriculturally used anti-bacterial) to be detected in combination with up to twenty seven different additional chemicals including pesticides and other antibiotics.(Barnes K.K. et al 2002).

Interactive effects may include additivity, antagonism and synergism and result in increases or decreases in the potential impact of these chemicals in the environment. (Boxall and Kolpin 2003) There continues to be limited research available on impacts of specific veterinary medicines on the environment, however, there appears to be a common understanding that these medicines are detectable and therefore may have an environmental impact beyond their initial use.

2.7. Recycling Attitudes and Beliefs

Farmers surveyed by BlackSheep Strategy place a very high level of importance on the responsible disposal of agricultural waste. 83% strongly agree that it is important while the remaining 17% somewhat agree. Despite this strong belief in the importance of responsibly disposing of agricultural waste, 21% of farmers surveyed consider themselves to have a lot of waste materials around their farms that they are unsure of how or where to safely dispose of. This disparity, between the values of farmers and their ability to behave in accordance with these values, provides an opportunity to change behaviours and affect positive environmental change through new diversion programs.

Fortunately, over 55% of farmers indicate that they are an uncomfortable with burning or putting certain products in landfills, despite the perception that alternatives are lacking. This attitude further adds to the impetus for positive change.

2.8. Restrictions to End of Life Management

2.8.1. Plastics

Table 9 – Plastic – End of Life Management Summary

Plastic Waste Stream	End of Life Solution			Regulatory Restrictions	Regulator
	Reported	Worst Case	Best Available		
Film Plastic – incl. Silage/Bale Wrap	landfill, some recycling	onsite burning	recycling	No	
Woven Bag Plastic	landfill, return to retail	onsite burning	recycling or disposal	Yes, if contaminated	Ministry of the Environment
Twine Products – incl. Net Wrap	onsite burning, landfill, recycling	onsite burning	recycling	No	
Sanitation products – drums, pails, jugs	reuse, recycling, return to retail	onsite burning	recycling	No	
Greenhouse and Nursery potted plant insets, trays pots etc.	recycled	onsite burning	recycling	No	
Potted Plant Sleeves	landfill, onsite burning	onsite burning	recycling	No	

In the instances when agricultural plastic waste is contaminated by chemicals or the presence of animal medication residues, these recyclable plastics become regulated under the Ontario Environmental

Protection Act (EPA). The EPA is administered by the Ministry of the Environment under ON Regulation 347 as amended and specifically requires that contaminated materials such as certain agricultural plastics be decontaminated prior to removal from the site or be treated as a hazardous recyclable/waste. An example of pre-treatment prior to handling would be the triple rinsing that farmers undertake when preparing pesticide containers for recycling.

2.8.1.1. Regulated Plastic - Feed Bags

In the case of feed bags, rinsing may not be an environmentally sound procedure, as the rinseate would likely be left on the ground or be flushed down the drain. In these situations collection and regulated management of contaminated feed bags is currently the only safe alternative.

Plastic wastes which fall under the regulated requirements of Reg. 347 include feed bags (PP) which have contained medicated feeds which appear on Schedules 1-4 of the Regulation.

The regulations require that these materials be handled through a controlled manifest system and be disposed of according to the classification under which they are shipped.

2.8.2. Paper Fibre

Paper fibre is the oldest and easiest of the agricultural materials of to recycle. However, the four categories of paper fibre material below present their own individual challenges for handling and recycling. Chief among these challenges is:

1. the presence of laminated plastics, liners and sleeves to paper bags,
2. the presence of chemical contamination from product residues, and,
3. the coatings or permeation of waxes and other materials which provide resistance to moisture.

Table 10 – Paper Fibre – End of Life Management Summary

Paper Fibre Waste Stream	End of Life Solution			Regulatory Restrictions	Regulator
	Reported	Worst Case	Best Available		
Kraft Paper Bags - Unlined (Seed)	onsite burning, recycling	onsite burning	recycling	No	
Kraft Paper Bags Lined (Feed)	onsite burning	onsite burning	recycling / regulated disposal	Yes, if contaminated	Ministry of the Environment
Cardboard Boxes	recycled, onsite burning	onsite burning	recycling	No	
Cardboard Boxes Waxed	landfill, onsite burning	onsite burning	disposal	No	

2.8.2.1. Regulated Paper Fibre – Seed Bags

Seed bags are a laminate/layered paper plastic combination bag which are used to ship seed to farmers. Of increasing popularity are pretreated seeds which are conditioned with pesticides in order to prevent disease or infestation. In those cases where pesticides or regulated additives are present in seed bags, the seed bags must be treated as a hazardous material and either recycled through a properly licensed waste management system or destroyed per a system under the same regulatory controls.

2.8.3. Animal Health Products

Animal health products occupy a unique niche within the materials under scrutiny in this study. This group contains separate packaging in the form of plastic and paper fibre material and also product which may range across various media including solids, liquids, semi solids, gasses (aerosols) and biologics and a wide variety of other medicinal materials.

These animal health products may contain chemicals whose disposal falls under regulatory restrictions by the Ministry of the Environment Reg. 347. There are a number of challenges which must be addressed within the context of industry standards, regulatory approvals and information requirements in order that a multi-tiered evaluation of animal health products can be effectively evaluated from a risk based standpoint.

There are thousands of products which are currently licensed, produced and imported under the regulatory authority of Health Canada. These products all include strictly approved labelling and packaging requirements. Any changes to these standards must pass through multiple levels of applications and approvals in order to be legally implemented. This heavily controlled approval process has the unintended impact of preventing simple changes to the packaging system which would enable manufacturers to communicate to the end user simple and safe ways to efficiently manage their animal health product waste.

A system design for the streaming of various products must be simple and effective in terms of directing the end user. Users at the farm level must be able to quickly and accurately sort regulated products from non-regulated products, and the associated contaminated packaging which requires destruction from that which can be recovered through recycling.

Based upon the current level of information which is provided to end users, there is a reasonable possibility that a significant portion of the product and packaging that they are handling could be considered regulated under provincial disposal regulations. Consequently, any product or packaging which may have become contaminated with product must be disposed of through a regulated disposal channel.

Integral to the risk of classifying all contaminated materials under the animal products category as hazardous, is the potential for “over disposing” of these products. This means that the lack of ability to easily and clearly categorize these materials as requiring hazardous disposal handling (or not) would require that all of the materials be directed to hazardous disposal. This overburdens all stakeholders including farmers who must segregate and carefully store materials, collectors who must employ rigorous packaging and shipping procedures, processors who must conform to the hazardous waste

processing requirements and stewards who will ultimately be required to pay for this overinflated and largely unnecessary cost structure.

In order to help prevent this from occurring, CAHI recommends, in the eBiz report, that a science based perspective be used which would be cost effective and outcome based. The obstacles to using this approach effectively, continue to be the regulatory restrictions on changes to product and package labelling,

The challenges of identifying and segregating these materials, as discussed above, continues to lie within the higher levels of Health Canada and other regulatory bodies as industry would be required to make some fundamental changes/additions to product packaging and labeling requirements in order to allow for the clear communication of environmental dangers and the appropriate handling protocols to the wide variety of end users, in particular those at the farm level.

The practical impact of a simple, environmental management, disposal labelling system when applied to animal health products would provide users with the immediate ability to safely and correctly stream their animal health products waste. This would impact manufacturers and importers by enabling them to avoid exceptionally high and unnecessary disposal costs which are applied when non-regulated wastes are disposed of through regulated channels.

Table 11 indicates the potential for all animal medicines and related packaging to require hazardous disposal if contaminated with hazardous materials. Under the 'Regulatory Restrictions' column, all the materials are either 'Yes', or a 'potential for Yes'. The question which must be decisively answered is "how can the user determine what is truly contaminated by a regulated waste?".

Table 11 – Animal Health – End of Life Management Summary

Animal Health Products Waste Stream	End of Life Solution			Regulatory Restrictions	Regulator
	Reported	Worst Case	Best Available		
Animal Medications	return to retail contracted disposal, landfill and onsite burning	onsite burning, landfill	regulated disposal	Yes, if contaminated	**Ministry of the Environment**
Glass Bottles	recycled, landfill	landfill	regulated disposal /recycling	Yes, if contaminated	**Ministry of the Environment**
Plastic Bottles	recycled, onsite burning	onsite burning	regulated disposal /recycling	Yes, if contaminated	**Ministry of the Environment**
Sharps - Bio-haz	return to retail (vets), take back programs, landfill	landfill	regulated disposal	Yes	**Ministry of the Environment**
Packaging - mixed - bags, plastic bottles, inserts, tubes, boxes	recycled, landfill, onsite burning	onsite burning	recycling /regulated disposal	No Yes, if contaminated	**Ministry of the Environment**

3. Collection Options

3.1. Regulatory and Technical Requirements for Category Waste Collection

There are two methods by which waste materials may be shipped in Ontario, as hazardous waste/recyclables or as non-regulated waste/recyclables.

3.1.1. Regulated or Hazardous Waste

Hazard waste would require the following when being collected, packaged, transported and disposed of in Ontario.

Consolidation Point – Any generator of hazardous waste shipping waste in Ontario must be registered with the MOE through the Hazardous Waste Information Network (HWIN). Any site acting as a collection point of regulated agricultural waste must be registered with the Ministry of the Environment as a waste receiving site and as a Generator unless they have received special dispensation or exemption from that requirement by the Minister's office.

Packaging – Any hazardous materials being offered for transport under ON Reg. 347 must be packaged in containers which are suitable to contain the material which they are carrying and must also conform to the standards required by the Federal Transportation of Dangerous Goods Act, such as UN approved drums, boxes, totes.

Shipping – Any waste materials leaving a collection site as a regulated waste must be manifested to an authorized and approved waste receiving facility that is licensed to receive the class of waste being shipped. All manifests used to ship hazardous waste materials must be signed by the Generator, who must be trained in the Transportation of Dangerous Goods and be familiar with material being offered for transport and qualified to offer it for shipment.

Transportation must only be performed by a carrier with a MOE license to ship the class of waste being offered for transportation.

Receiving – All manifested waste must be only be sent to a facility which is authorized by the governing agency in which it resides to receive the class of waste being offered for recycling or disposal. Manifest copies must be returned to the Generator for record storage and to the Ministry of the Environment for reconciliation with Generator copies previously received.

Waste materials under consideration in this Study which will require handling as hazardous material may include the following:

- Feed bags - treated
- Seed bags – treated
- Animal health products
- Animal health product packaging – contaminated with hazardous product

It should be noted that the Ministry of the Environment, Regulation 347 has, on occasion, been amended to allow for the "practical" management of materials which pose a low or manageable risk.

Examples of materials or processes which have been exempted from all or part of the regulation include special provisions for recycling paint, batteries, fluorescent bulbs, and obsolete pesticides. In the past, the MOE has responded to the needs of industry and society to facilitate easier recycling or collection of certain categories of materials. This legislative course of action may be an option to pursue in terms of establishing a new regulatory framework which would in turn provide for a simple, cost effective solution for treated seed bags, feed bags and animal medicine packaging.

3.1.2. Non-Regulated or Non-Hazardous Waste

Non-regulated waste in Ontario is subject to far less stringent management and tracking controls than its hazardous counterpart.

Collection Point – Non-regulated waste can be collected at a facility which is licensed or permitted to receive nonhazardous solid waste. Common examples of these facilities are municipal landfills, recycling drop off stations, permitted collection points under special provisions of the EPA, such as empty pesticide container drop off depots.

Packing – Non-regulated solid materials offered for transport are expected to be packaged, bound, or otherwise contained in a manner that facilitates their intact arrival at the intended destination. UN shipping standards or packaging requirements are not applicable.

Shipping – a simple Bill of Lading document identifying the material and volume being shipped, the Consignor, Consignee and Destination are acceptable for the legal transport of these materials.

Receiving – The destination to which the material is shipped must be a facility licensed to receive the recyclable material shipped. In the case of a packaged commodity sent directly to a processor, a facility waste receiving license is not required.

Waste materials which may be shipped as non-regulated recyclables may include the following:

- Film Plastic – incl. Silage/Bale Wrap
- Woven Bag Plastic
- Twine Products – incl. Net Wrap
- Plastic Jugs, Pails and Drums
- Greenhouse and Nursery potted plant insets, trays pots etc.
- Potted Plant Sleeves
- Paper Fibre
- Kraft Paper Bags Unlined - untreated seed bags
- Kraft Paper Bags Lined -incl. laminates, ‘untreated feed’ bags
- Cardboard Boxes
- Cardboard Boxes Waxed
- Animal health product packaging not contaminated with regulated product

3.2. Short Listed Collection Options

A number of different agricultural waste collection options were considered in the January 2010 eBiz report entitled **Collection and Disposal of Unwanted Agricultural Pesticides and Animal Health Products in the Great Lakes Basin.** The focus group consultation process reduced these options under consideration down to the following list:

- event based,
- depot based,
- permanent back to retail, and,
- private contractor.

3.2.1. Event Based

This option is the same approach used by CleanFARMS Inc. for the collection of unwanted and obsolete pesticides at various locations across Ontario. In 2009, during a previous collection blitz, CleanFARMS partnered with AGCare to pilot the collection of animal health products and sharps. According to the eBiz, report the event successfully collected 77 boxes of sharps, 86 boxes of animal health products, 4 totes of animal health products, and 116,000 kg of pesticides.

The key components of this collection approach are:

- the use of multiple, temporary collection points
- the management of one or more streams of materials
- the ability to dedicate staff to ensure events are run safely, and efficiently and according to event licensing requirements, as applicable.
- events are held according to a predetermined schedule, on intervals as determined by stakeholder management groups.

The advantage of an event based approach is that they can efficiently and effectively manage a number of collection issues such as:

- regulatory requirements of handling regulated /hazardous waste including permitting, manifesting, training and safety considerations
- event based overhead costs of managing low volume materials can be distributed across a number of waste streams and stewards.
- changing frequencies of events as needed to meet the needs of the users.
- changing composition of materials collected based upon site resources and user needs.
- satisfying the varying criteria of stakeholders such as government, industry and farmers.

The designated collection point could be a municipal site, an agricultural retailer or an alternative type of site with a suitable amount of space and convenient access for local farmers.

3.2.2. Depot Based

Depot based collection is likely the broadest collection event with the ability to capture the largest volumes and widest variety of materials. This collection approach could be applied very easily at a municipal waste transfer station that is set up to collect a number of different categories of products. Typically these locations are not return to retail locations due to space limitations in terms of being able to provide the area necessary to deliver the convenience of multi material drop-off services and the ability to receive significant volumes of materials.

The key components of this collection approach are:

- the ability to receive a broad range of materials,
- the ability to collect large volumes of materials,
- the necessary permitting to operate a collection system,
- depot are open for receiving material for most, or all of the year, and,
- the location is convenient to farmers and encourages participation.

The advantages of this depot based approach are:

- the low cost of operations, as the depot is typically used for a number of other purposes, besides agricultural waste,
- the space for large volume collection, allowing for lower shipping costs to the final destination,
- the tendency for complimentary services to be housed at the same location, providing a convenience factor and efficiency to users, and,
- the opportunity for the maximum amount of material to be collected at one location.

A municipal landfill or transfer station is an ideal Collection Depot as they are regularly used by the farming community and are typically interested in supporting alternative diversion programs that will assist them conserve landfill space.

3.2.3. Permanent Back to Retail

CleanFARMs has very successfully leveraged this collection approach in its Empty Pesticide Container Management Program, which uses licensed pesticide dealer depots as points of return for container collection across Ontario. This allows consumers to return used containers when they come to pick up a new supply of pesticide products. This practice is also used at a number of veterinarian offices and retailers of animal health products, although not quite as widely as the CleanFARMS program.

The key components of a permanent back to retail approach are:

- locations are typically limited to few or single streams,
- retailers are supportive of the program as it allows them to participate in a positive environmental initiative,
- program access is not limited by seasonality, just retail operating hours, and,
- government, industry and farmers are typically supportive of this approach because of the logical presence of the retailer at the beginning and end of the product life cycle.

The advantages of a Permanent Back to Retail based collection program are that:

- users are encouraged and supported in adopting sound material management practices at a critical decision making point in the material life cycle
- communications and promotions are effectively targeted to the user at a logical high impact location – the retailer
- locations are convenient to the users for dropping off materials as they are going to the site to purchase new supplies

Optimal locations for permanent back to retail locations are:

- various agricultural retailers of plastic films, twines, wraps, greenhouse film, containers, pots trays and accessories and other packaging products,
- chemical suppliers of sanitation products, micro nutrient retailers, and pesticide depots, and,
- animal health related groups such as veterinarian clinics, hospitals and agricultural colleges.

3.2.4. Private Contractor

Private contractors are the most widely accessible option that farmers utilize access in terms of acquiring recycling and disposal options for their farm generated wastes. The largest obstacle to the provision of these services is that famers are required to pay directly out of their pockets for the service and many are reluctant to do so. Apart from cost, concerns that farmers have when using commercial services relates to the confidence of knowing that the various different waste streams that they are paying for the removal and management of are actually going to the intended recycling and recovery destinations, rather than straight to landfill or destruction.

The key components of the private contractor collection approach are:

- the contractor provides the ease and convenience of removing all of the waste materials on an immediate basis,
- sorting is performed by the contractor, which eliminates the need for farmers to source separate all of the different types of plastic and waste products,
- there is a fee associated with all service visits which generally comprise tipping fees per tonne in addition to transportation charges,
- service is performed at the farm, and,
- service is always available.

Since service is provided directly to the farmer, the optimal location is the farm or other location that the farmer requests. This service provides the highest levels of convenience; however, for farmers with lower volumes of materials, costs may be prohibitive.

3.3. Collection Framework and Approach

3.3.1. Material Volumes for Collection

The following Table 12 represents material volume estimates which have been based upon market surveys conducted by a number of separate studies performed during the Phase l portion of this project.

Table 12 – Agricultural Waste Streams for Collection

Waste Stream	Estimate Annual Volume (in Tonnes)	Total
Plastic		
LDPE		
Greenhouse Film	265	
Mulch Film	460	
Silage Film and Bale Wrap	2400	
Fertilizer and Grow Bags	385	
HDPE		
Sanitation Drums, Jugs, Pails	1115	
PP and mixed		
Twine	530	
Net Wrap	697	
Feed Bags- woven	490	
Greenhouse and Nursery PP (mix of PS & PE also)	565	6,907
Paper Fibre		
Cardboard – OCC	4,780	
Cardboard - OCC Waxed	1,050	
Kraft Paper Bags Lined	240	
Unlined Kraft Paper Bags – Treated Seed Bags	400	6,470
Animal Health Products		
Animal Medications	1	
Glass Bottles	1097	
Plastic Bottles	67	
Sharps	9	
Misc. Packaging (inserts, tubes, foil bags)	4	
Paper/Plastic Bags, clamshells, blister sheets, aerosols etc)	8	
Cardboard Boxes – (recoverable through OCC collection)	8	1194
		14,571

3.3.2. Collection Methodology

The waste streams under consideration have been divided into a number of groups based upon volume, technical requirements of handling the waste streams and limitations under which safe and responsible source separation of regulated and non-regulated materials can be achieved.

This proposed division is based upon the best available information for managing this material and also takes into consideration the ability of the users to correctly and accurately present their waste for collection. This qualifier is particularly relevant in the case of animal health products where the diversity of products available on the market in terms of chemical composition, country of manufacture, impact of product contamination, and other similar factors strongly impact the potential for a safe and responsible program based upon user knowledge and judgement.

The following collection approaches are proposed for the waste streams identified in Table 12. These approaches address the unique generator profiles of each waste stream provide collection efficiencies and also maintain regulatory compliance.

3.3.3. Event Based

What to Collect - Materials included in this program will be:

- Animal Health Product Category sharps, products and packaging,
- Unlined Kraft Paper Bags – Treated Seed Bags (from the Paper Fibre Category)
- Plastic Feed (from the Plastic Category).

In the absence of a definitive breakdown between bags which are contaminated or not contaminated and the challenge of users discerning between sorting and segregating these types of materials, the 'estimated volumes' of materials available for collection have been used for each item in the preparation of the cost estimate.

Additionally, in order to illustrate the financial burden of "over disposing" of animal health medicines, and related category packaging materials, the event based scenario has been contrasted under a hazardous and a non-hazardous processing and handling system. Under the non-hazardous system, only the sharps and medicines would be considered to be hazardous.

These collection events would be held in conjunction with regularly scheduled CleanFARMS Obsolete Pesticide Collection Events. There are a number of drivers behind the rationale for this combination of materials to be collected at the same time and are as follows:

- pesticides, animal health products and contaminated bags could be handled in a controlled manner, whether they are treated as hazardous or non-hazardous wastes,
- special regulations or handling procedures for material movements could be managed under a common infrastructure in terms of technical paperwork and administrative requirements, licensing/permitting of sites, carriers and receivers,
- training of staff may also be similar in terms of requiring TDG certification for authorized Generator staff ,

- materials may have similar destinations for destruction,(except for designated bio-hazardous materials).

Where to Collect - Pesticides, animal health products and contaminated bags will be collected at agricultural product retailers at approximately 16 sites across Ontario. These sites are strategically distributed in order to maximize the coverage area that provides the greatest access to the farm community while ensuring that the overhead event costs are minimized.

When to Collect – Collection under this event based program occurs every three years in Ontario. This has been determined, through the Obsolete Pesticide Collection Program experience, in consultation with users, as an acceptable frequency for events.

A key component to the success of this approach in the context of animal health products is the increased practice of the BUD approach – buy what you need, use what you buy, and dispose of it properly. This philosophy supports lowered volumes of animal health products being generated as obsolete products and shifts the volume of materials to be collected towards spent materials and contaminated materials.

The collection of treated seed and feed bags should also be amenable to a three year frequency as the bags are easily contained within each other and stored for disposal. The volumes of these materials are less than the potential volumes of animal health products; however, further education of the farmers would be required in order to develop awareness of how to properly dispose of these materials. Specifically, this would enable the users to determine the difference between regulated and non-regulated waste packaging.

Additionally, the continued removal and return of unused and spent animal health products from the farm site back to veterinarian offices and professional clinics has the added impact of removing waste volumes from the farm and ensuring materials are handled by more knowledgeable individuals who are familiar with acceptable disposal practices. This in turn places less reliance on event based collection as a sole means of addressing animal health product disposal challenges in Ontario.

According to research conducted by eBiz in the previously cited 2010 report, only 28.2% of farmers store or dispose of animal medicines on the farm. This behavioural pattern more clearly puts into perspective the amount of medicines which may require an improved disposal process. Additionally, only 10.8% of farmers of the 28.2% cited above actually dispose of these medicines on the farm. It is also very likely that the stored medicines are being kept for use at a later date and are not actually available for disposal,

How to Collect – Regulated animal health products would be collected using UN approved packaging such as waste wranglers (cubic metre sized, lined, PP fibre reinforced, cardboard boxes) and drums for smaller quantities. These materials would then be manifested to their final destinations for disposal. In the case of materials that would be classified as bio-hazardous, the collection contractor would provide UN approved container which are approved and suitable for the collection of this material. Containers may vary between 20 KG poly-lined boxes, to 20 Litre plastic pails, to 325 Litre wheeled totes.

Materials which are managed under a non-hazardous scenario would be baled and shipped to an appropriate facility for destruction.

Figure 14 – UN approved Waste Wrangler and Drums

3.3.4. Depot Based

What to Collect – Materials collected under this approach will include the bulk of plastic and paper fibre materials. These materials would be considered non-regulated under ON Reg. 347 criteria. The drivers behind combining this group of material together are as follows:

- materials share a similar non-regulated designation,
- large volumes are generated annually,
- collection requires substantial space for logistic containers,
- depots are self-administered or require little oversight by available staff, and,
- multiple material efficiencies can be leveraged in the transportation and recycling process.

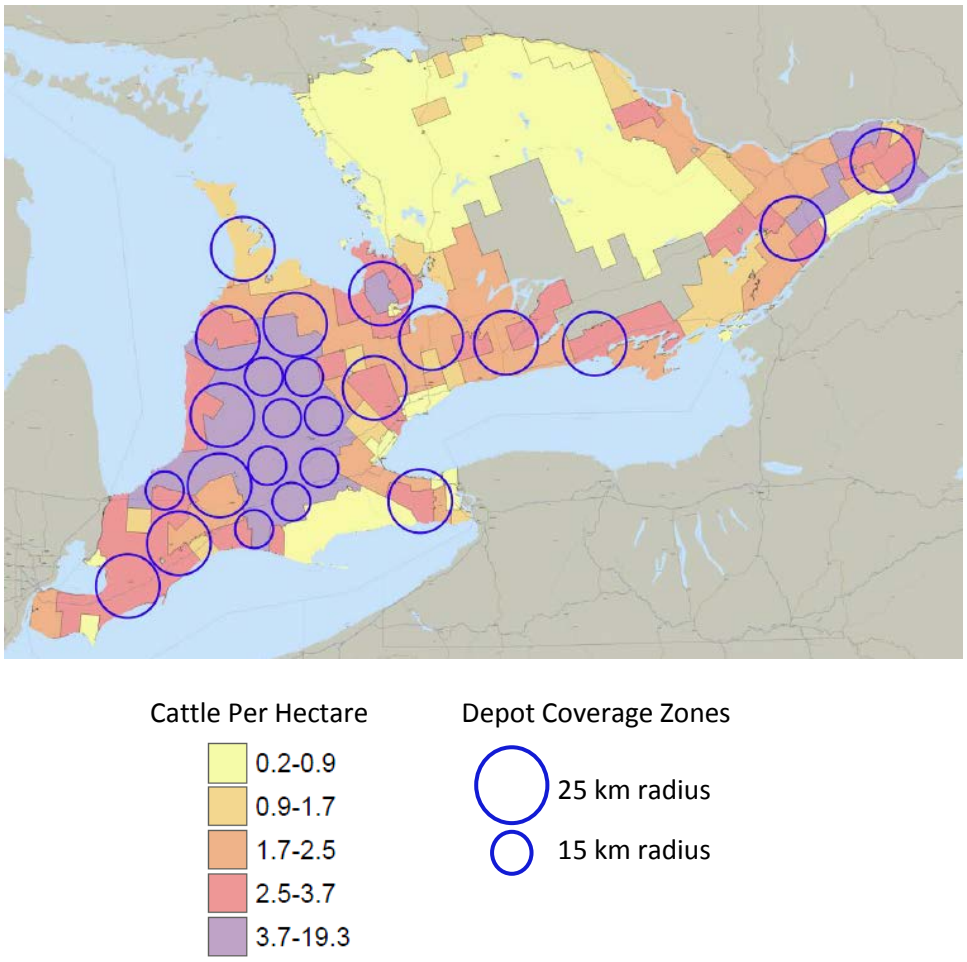
Where to Collect – Collection Depots would be strategically located throughout the province using locations which ideally provide associated value and service to the agricultural community. Although municipal organizations such as the Association of Municipalities of Ontario (AMO) claim that their members are not mandated to provide services to the agricultural community, consultation with stakeholder groups indicate a different attitude. Municipalities contacted through related project research have indicated that they actually are interested potential partners. Municipal sites often offer the advantage of having available space and providing complimentary services, such as landfill or tipping services for waste. It appears that municipalities view the diversion of highly recyclable materials as a direct benefit to preserving their own scarce landfill resources and are not averse to assisting with this for the agricultural community.

The model for collection utilizes 24 collection depots placed across Ontario. These site locations have been selected based upon their proximity to high density cattle farming areas. The correlation between these sites and the production of bale wrap and silage wrap is high and would maximize the return rates of these materials based upon the number of sites selected. Within high cattle density areas, i.e. with

greater than 3.7 cattle per hectare, a general service radius of 15 km per depot was used, while in less densely cattle populated areas a 25km radius was used. Figure 15 below illustrates the coverage of service areas overlaid on a cattle density map.

This model has not specifically sited collection depots as negotiations have not taken place with potential partners or agreements been designed, however, all of the municipalities within which a proposed depot could be located, have either landfill sites or transfer stations present.

Figure 15 – Depot Collection Sites Based Upon Cattle Per Hectare Density Rates



When to Collect – Collection frequencies for the subject materials are heavily dependent upon the production of packaging waste such as plastic film which is generated prior to the planting and harvesting seasons. These seasons include a surge of materials as farmers purge their farms of materials such as bale, silage and net wrap after winter and also during the fall season as farms are prepared for the winter shut down. It is anticipated that the heaviest collection periods will be approximately from April 1 to June 30 and then again during the period August 1 to October 31.

How to Collect – Collection of plastics and paper fibre materials will require a robust system which meets a number of criteria, including:

- protection from the elements – this maintains site security and avoids the migration of waste recyclables offsite during inclement weather. It also prevents the degradation of material quality as rain can reduce the quality of OCC and paper products, while UV radiation can degrade plastic quality, all of which results in lowered recyclable value to the end market.
- segregation from dissimilar waste streams – sorting must be done by the program participants and is not accounted for in any labour overhead costing.

- material deposited must be protected from scavenging and loss.
- the system must be simple to use and understand.

Figure 16 illustrates the collection containers which are proposed to be situated at the various Depot sites.

Figure 16 – Agricultural Waste Collection Bins

The system utilizes a 6 bin setup to capture the full range of materials, and would be applied as follows:

- Bin 1 1 compartment
  - bale wrap and silage film
- Bin 2 3 compartment
  - greenhouse film
  - mulch film
  - different films delivered in clear plastic bags to allow for separation
- Bin 3 1 compartment
  - HDPE Containers
  - would include jugs, drums and pails
- Bin 4 4 compartment
  - twine
  - net wrap
  - PP & PS greenhouse pots/trays,
  - untreated PP feed bags
- Bin 5 1 compartment
  - cardboard – OCC
  - (can include co-mingled kraft paper bags - unlined)
- Bin 6 2 compartment
  - waxed and coated OCC
  - kraft paper bags - lined

Bins would be equipped with internal, movable dividers which would prevent mixing and cross contamination. Additionally, there would be sliding access doors on the side of the bin and locked gates

in order to maintain security. All bins would be enclosed to ensure protection from the elements and as added security against loss.

On a two week basis or earlier if needed, a mobile baler would attend the sites to condense materials into 6'x3'x3' bales prior to removal to processing sites.

3.4. Cost Benefit Analysis of Collection Options

3.4.1. Event Based - Animal Health Products and Contaminated Packaging

There are five main cost components to an event based collection program for materials which could be classified as either hazardous or non-hazardous. These components include:

- overhead costs include fixed costs – advertising and promotions, administration
- event setup
- packaging
    - supplies – UN approved packaging, or
    - baling
- transportation costs to move material to the end processor
- disposal costs to process the materials

As a result of the uncertain classification of these waste materials and the corresponding significant variations in handling and disposal cost that the differing classifications include, the hazardous and non-hazardous disposal cost scenarios for animal health products and contaminated packaging have not been included in the overall study costing model. Alternatively, the two scenarios have been discussed in this section only, for the sole purpose of illustrating the financial implications to stakeholders and interested parties.

3.4.1.1. Event Based Scenario Assumptions

A number of assumptions were made as a result of the inclusion of these category wastes in an Obsolete Pesticide Collection Event. Assumptions are as follows:

- wranglers were utilized for 90% of the material volume at a cost of $125 each
    - wranglers hold 500KG of material
- drums were utilized for the balance of the material at a cost of $35 each
    - drums hold 80 kg of material
- bio-hazard disposal containers are included in the $/KG cost of disposal of these materials.
- Start-up event overhead cost contributions were slightly larger than estimated by eBiz in **the Collection and Disposal of Unwanted Agricultural Pesticides and Animal Health Products in the Great Lakes Basin Study**, however, were based upon this framework and include the following:
    - communications,
    - administration (incl. HWIN), and,
    - program management and development.
- mature program costs were based upon the development of a reproducible operational model and increased participant familiarity and experience
- a 16 site blitz was held every three years.
- event management costs are presented on an annualized basis.

Table 13 - Event Based Overhead Cost Summary

Event Overhead Costs	Start-up Program Costs	Mature Program Costs
Leadership and Administration	$41,250	$30,000
Communication and Promotion	$60,000	$60,000
Training and Education	$75,000	$16,000
Facility and Equipment Setup	$45,000	$16,000
Travel and Related	$5,000	$1,000
Event Staging Cost Estimate, per 3 year event	$226,250	$123,000
Annualized Cost (per year)	**$75,417**	**$41,000**

3.4.2. Disposal Cost Allocation

Disposal costing of the selected materials includes the following:

- animal health products – including packaging
- contaminated plastic feed and paper seed bags

3.4.2.1. Non-Hazardous Classification

Under the non-hazardous scenario, the majority of animal health products (which includes bio-hazardous material and sharps) and contaminated packaging would be handled as non-hazardous materials. This material would be processed in bulk through incineration and recycling channels. Incineration would be carried out via a non-hazardous waste incinerator located in New York State (or domestically, should those options become viable). The glass containers would be handled through one of a number of domestically available glass grinding and recycling facilities.

The approach of managing all of the treated seed bags, feed bags and animal medicine packaging as a non-hazardous waste would incur a disposal cost of approximately $300,000 annually which includes collection, transportation and disposal considerations.

The glass bottles, under a non-hazardous program, could be managed through a municipal processing and recycling system and would incur transportation and handling costs of approximately $75,000 annually.

While the bulk of material under consideration in this scenario would be classified as non-hazardous, there would still be a small volume of sharps and medications which would be required to be treated as a regulated, i.e. hazardous, waste. Material management costs would be approximately $62,000, annually, to dispose of this material through a regulated Ontario medical waste contractor.

Under this scenario, a mature program overhead cost estimate has been utilized in order to most accurately represent the costs of operating an ongoing, established service. Furthermore, the costs above have assumed a 100% recovery rate, as detailed in Table 14, in order to illustrate the upset limit of the cost of this scenario.

Table 14 – Non Hazardous Scenario – 100% Recovery, Event Based Collection Cost Summary

Stream	Plastic and Paper Bags and Misc. Packaging	Glass Bottles	Animal Health Products	Cost
Volume (tonnes)	969	1097	10	
Packaging and Transportation	$190,000	$75,000	$3,000	$268,000
Disposal Costs	$110,000	$0	$59,000	$169,000
			Subtotal	$437,000
Event Based Overhead Costs	16 Events	Annualized Allocation		$41,000
		Total Scenario Costs		**$478,000**

Table 15 illustrates a number of possible scenarios that may be realized when less than 100% of the available materials are recovered. Again, this model includes a mature overhead cost allowance as it best represents the estimated costs of operating the stewardship system in the long term, rather than under start up conditions.

Table 15 – Non Hazardous Scenario - Cost Model for Incremental Material Recovery Volumes

	% Recovery				
Cost Item	**10%**	**30%**	**50%**	**80%**	**100%**
Waste Volume (Tonnes)	208	623	1,038	1,661	2,076
Disposal Cost	$ 17,000	$ 51,000	$ 85,000	$ 135,000	$ 169,000
Transportation Cost	$ 27,000	$ 80,000	$ 134,000	$ 215,000	$ 268,000
Event Staging Overhead	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Total Cost	**$ 85,000**	**$ 172,000**	**$ 260,000**	**$ 391,000**	**$ 478,000**

Appendix 9 – Non-Hazardous Disposal Scenario with Variable Recovery Volumes, Tables 1-4 illustrate possible non-hazardous costing scenarios if the waste streams were to be operated under separate, independent programs. These tables also include cost models for the incremental recovery of material volumes.

3.4.2.2. Hazardous Classification

Under a hazardous waste classification, animal health products are destined for an Ontario based waste medical waste destruction facility. This particular facility is owned by the largest medical waste management company in Ontario, and is solely capable of providing the full range of services under this product grouping. Historically, animal health stakeholder groups have piloted collection and disposal initiatives using this service provider that have proven effective in supplementing the existing, compliant practices of animal health care professionals and farmers.

The packaging materials from the collection of contaminated plastic feed and paper seed bags is destined for a destruction facility in Alberta that is the largest processor of hazardous solid and difficult to manage wastes in Canada. This material has been directed to the Alberta facility as the MOE regulations in Ontario, as they apply to differing waste classifications of material, would prevent this material from being shipped with and received by the same contractor who can accommodate the bio-hazardous and pharmaceutical relate waste streams.

Under the collection model currently proposed, the potential volumes of event based waste include all the materials itemized in Table 16 below. Wrangler and drum usage has been factored into the supplies calculations based upon a 90:10 utilisation rate.

Table 16 – Hazardous Scenario – 100% Recovery, Event Based Collection Cost Summary

Stream	Plastic and Paper Bag	Glass Bottles	Animal Health Products	Cost
Volume (tonnes)	957	1097	22	2,076
Packaging	$257,000	$295,000	$6,000	$558,000
Disposal Transportation	$204,000	$47,000	$1,000	$204,000
Disposal (incl. packaging weight)	$2,822,000	$6,471,000	$130,000	$9,423,000
Event Based Staging – 16 sites	annualized allocation			$41,000
	Total Scenario Costs			**$10,226,000**

Table 16, above, illustrates potential costs under a 100% recovery scenario. The disposal charges for the projected volume of materials within the event based program includes the weight of the packaging containers (drums and wranglers). The transportation costs associated with delivering these materials to the end processors is based upon the number of trips (at approximately 20,000 kg per load), required to move the event waste to the two selected end processors.

Material disposal cost estimates for the animal health product and packaging waste streams are biased to the high side. This is principally due to the lack of clearly worded and appropriate product information and disposal procedures being communicated to the end users in a manner that allows the user to distinguish between regulated and non-regulated materials and recyclable and non-recyclable materials.

It should be noted that this inability to provide more complete information is not necessarily due to a lack of desire by domestic industry, but rather is likely more indicative of the constraints placed upon the industry by multiple layers of regulators and the macro practices of a globalized, animal health product industry.

The following Table 17. illustrates different collection cost scenarios, under various material recovery rates. As overhead costs are not significant when considered in the context of overall system costs, it is clearly evident that material volumes are the primary driver of stewardship (collection and disposal) costs and program effectiveness.

Table 17 – Hazardous Scenario - Cost Model for Incremental Material Recovery Volumes

	% Material Recovery				
Cost Item	**10%**	**30%**	**50%**	**80%**	**100%**
Waste Volume -Tonnes	208	623	1,038	1,661	2,076
Disposal Cost	$ 942,000	$2,827,000	$4,712,000	$7,539,000	$ 9,423,000
Supplies Cost	$ 56,000	$ 167,000	$ 279,000	$ 446,000	$ 558,000
Transportation Cost	$ 20,000	$ 61,000	$ 102,000	$ 163,000	$ 204,000
Event Staging Overhead	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Total Cost	**$1,059,000**	**$3,096,000**	**$5,134,000**	**$8,189,000**	**$10,226,000**

Appendix 9 – Hazardous Disposal Scenario with Variable Recovery Volumes, Tables 5 - 8 illustrate possible hazardous costing scenarios if the waste streams were to be operated under separate, independent programs. These tables also include cost models for the incremental recovery of material volumes.

3.4.2.2.1. The Cost of "Over Disposing" of Waste

The re-categorization of the above noted materials would reduce the packaging and handling costs for the sharps and medicines to approximately $62,000 per year under a 100% recovery scenario. Inclusive of the annualized overhead costs, the total for managing the packaging component as a non-hazardous material is estimated to be approximately $478,000.

These costs illustrate the very significant burden created by "over disposing" of this category of materials, as the regulated disposal cost estimates, at a 100% recovery rate, are approximately $10,226,000; over 20 times larger than the disposal costs associated with the use of non-regulated channels.

There is a strong likelihood that a significant volume of these materials could be diverted through non-regulated, recycling channels under a revised packaging communications approach or may in fact be already managed by a private contractor through a professional veterinary clinic or similar entity.

It should be clearly understood that this costing illustration is not intended to be an indication of true disposal costs but rather an example of how the disposal cost estimates could be skewed without the implementation of a classification and identification system for managing animal products and category packaging materials.

As a result of the broad ranging cost estimates for the management of the animal health products, the costing profile for this combined waste stream has not been included in the overall costing model. In order to more clearly understand the cost structure for identifying, managing and handling these wastes materials, changes will need to be made at the regulatory and steward levels. Currently, no clear system exists for end users to discern between materials requiring regulated destruction and those that can be handled through traditional recycling or disposal systems.

3.4.3. Depot Based - Plastic Packaging and Paper Fibre Recyclables

A Depot Based collection program is the most efficient manner in optimizing the volumes of recyclable material diverted from onsite burning and landfill. The placement of depots at landfills or transfer stations further enhances the potential for redirecting materials through diversion channels rather than destruction or burial.

There are five key components to the collection model for a depot based approach. These components are:

- baling costs for plastic and paper fibre
- logistics containers – finance costs
- depot overhead costs – which include communications, administration and program development
- disposal of non-recyclable or revenue neutral materials
- transportation costs to deliver materials to the end processors

3.4.3.1. Baling

Baling Cost Assumptions
A number of assumptions were made when calculating the collection costs and preparation of materials for sending to the processor.

- materials would be evenly distributed across all depot sites.
- all material streams would be equally available, and be received in proportion to their use within the agricultural industry.
- baling fees are $75/hour,
- travel and accommodations cost per nights per site = $225/night
- the volume of materials to be collected at 24 depots across Ontario totals 12,487 tonnes of plastic and paper fibre.
- baling costs assume 100% recovery of available materials

Baling cost calculations - Based upon an average distribution of materials across all sites, each site is expected to receive approximately 21.7 tonnes of material every week.

- baling rate = 1 tonne per hour X 8 tonnes per day X $75/hour X 5 days per site = $1,500/2 week
- travel and accommodations per site = 4 nights x $225 = $900
- total baling costs per site per 2 week interval = $2,400/week
- total number of 2 week cycles per season = 12
- total number of depot collection sites = 24

Total baling costs: Cost per cycle = $2,400 x 12 cycles per season X 24 sites = $691,200

3.4.3.2. Logistics Containers

Logistics Bin Cost Calculations – Calculations below incorporated a 10 year amortization period, which reflects the light duty purpose for which the logistics bins would be used.

Total capital costs for logistics bins are as follows:

Table 18 – Logistics Bin Cost Summary

	Bins Required		
6	per site		
24	sites		
144	Bins required		
$6,500	cost per bin		
$936,000	amortized capital investment		
$136,275	**annual finance cost when amortized over 10 years at 8%**		

3.4.3.3. Depot Overhead

Depot Overhead Cost Calculations - Depot overhead costs include administration, overhead allocation, communication and other related operational expenses.

Table 19 - Depot Based Collection Overhead Cost Summary

Depot Collection Overhead Cost Center	**Cost**
Leadership and Administration	$120,000
Communication and Promotion	$72,000
Travel and Related	$24,000
Depot Cost Estimate – annual	**$216,000**

Considerations - Staging bins at municipal sites may require a fee for placement or revenue sharing in terms of covering management expenses for the operations of an agricultural waste collection station depot. Additionally, a number of municipalities have indicated strong support for an agricultural waste disposal program, however, they have indicated that support would be tempered by the degree of impact a program might have on existing operations.

According to this model, municipal sites would be required to locate up to six roll off bins onsite, with an approximate footprint of 4,500 square feet. The setup area would be required to provide access to the bins from all sides to allow for the loading of bins and the servicing of collected materials, in particular from the gates at the rear of the bins.

3.4.3.4. Disposal or Processing Costs

A number of materials which require diversion from on-farm burning or landfill destinations are not currently recoverable via readily available recycling or processing technologies. A number of criteria contribute to the difficulties of reclaiming these materials which include:

- the presence of organic content – high concentrations of organic matter require processors to spend additional resources decontaminating the material streams through either dry or wet wash processes.
- material cross contamination – the presence of incompatible materials such as product residues, laminated or layered materials, or compound packaging materials also require the application of additional recycling resources which can make material recovery cost prohibitive or impractical
- coated materials such as waxes, paints, varnished or special finishes reduce the recovery value of materials and can often prevent recovery.

Current problematic materials within the agricultural waste stream are summarized in Table 20 below:

Table 20 – Non-Recoverable or Non-Recyclable Agricultural Waste Material Profiles

Waste Stream	Material	Reason	Tonnage
Mulch film	LDPE	High organic contamination	460
Fertilizer and grow bags	LDPE	Product contamination	385
Net wrap	PP	High organic contamination	697
Cardboard - OCC waxed	Paper	Coated	1,050
Kraft paper bags lined	Paper Plastic	Mixed materials	240

Currently, the effective solutions for managing the end of life of the non-recoverable materials are located in the United States. These processes and available volumes are summarized in Table 21.

Table 21 – Processing and Disposal Opportunities for Non-Recoverable Streams

Waste Stream	Destination	Process	Tonnage
Mulch film	United States	Thermal Recovery	460
Fertilizer and grow bags	United States	Thermal Recovery	385
Net wrap	United States	Gasification	697
Cardboard - OCC waxed	United States	Thermal Recovery	1,050
Kraft paper bags lined	United States	Thermal Recovery	240

Table 22 – Disposal Cost for Non-Recoverable Streams

Waste Stream	Cost	Tonnage	Total
Mulch Film	$125/tonne	460	$57,500
Fertilizer and grow bags	$125/tonne	385	$48,125
Net Wrap	No charge	697	$0
Cardboard - OCC Waxed	$125/tonne	1,050	$131,250
Kraft Paper Bags Lined	$125/tonne	240	$30,000
		Total	**$266,875**

Delivery of net wrap would see a lower cost per trip since the material could be delivered to a domestic location, managed by the end-processor which is located in Ontario. This would preclude the need to send the truck across the border to the United States and could still realize cost savings from a milk run transportation approach. Similar to the other materials in these categories, multiple stops would need to be made in order to consolidate a full load for delivery.

Table 23 – Transportation Costs for Non-Recoverable Streams

Waste Stream	Cost Per Trip	Tonnage	Trips	Total
Mulch Film	$1,600/20 tonnes	460	23	$36,800
Fertilizer and grow bags	$1,600/20 tonnes	385	19	$30,400
Net Wrap	$1,200/20 tonnes	697	35	$42,000
Cardboard - OCC Waxed	$1,600/20 tonnes	1,050	53	$84,800
Kraft Paper Bags Lined	$1,600/20 tonnes	240	12	$19,200
		Total		**$213,200**

The Depot based collection cost estimates, based upon collecting 100% of the available materials volumes has been calculated at an upset limit of $1,523,550, as detailed in the following Table 24.

Table 24 - Depot Based Collection Cost Summary

Item	Cost
Baling and Onsite Services	$691,200
Logistics Containers – annual	$136,275
Overhead Cost	$216,000
Disposal Costs	$266,875
Transportation Costs	$213,200
Depot Cost Estimate – annual	**$1,523,550**

3.4.4. Non-Recyclable Agricultural Waste Collection Cost Summary

The above proposed cost estimate include the resources required to collect, package and prepare the non-regulated waste materials for transportation and recycling/disposal as needed.

Event based cost considerations for the management and processing of potentially contaminated packaging and animal medicines has been removed from the total program cost model in order to avoid skewing the costing results of this analysis and misrepresenting the potential cost obligation of product stewards. In consideration of a costing range which varies by a factor of almost 10 times, further work must be undertaken to build a better classification methodology prior to management by an EPR system.

Based upon commercially available disposal and collection costs, adjusted program estimates are expected to total approximately $1,523,550. This cost may display significant fluctuations as a result of changes in market rates and material volumes. As the end markets continue to develop and more robust technologies are applied to recycling systems, it is possible that materials may be able to be shifted from the non-recoverable category to the recoverable stream over time.

4. Processing Options

Processing options for the spectrum of agricultural materials within the focus of this study range from destruction for regulated and difficult to manage wastes to recycling options. This processing model includes waste streams which can be diverted to recycling processes and that have revenue generation potential.

4.1. Depot Based Collection of Recyclable Agricultural Waste Streams

4.1.1. Greenhouse Film

Greenhouse film is an LDPE film which is typically clear and easy to manage. As with many of the plastics, greenhouse film can be augmented by manufacturers to suit specific purposes such as managing light through opacity coatings, additives or laminated layers, or increasing heat retention through the addition of various polymers and changes to the plastic formula. A processor in the United States currently processes over 1 million pounds of clear film every month and would be able to introduce additional volumes without difficulty. While their location is the furthest destination to be considered for sending material, there are significant backhaul opportunities for trucking which allow for efficiencies in the delivery of material.

4.1.2. Silage Film and Bale Wrap

Silage film and bale wrap are the recyclable plastic films with the greatest likelihood of high organic contamination. These films have historically been stored in piles on the ground after use, and are a somewhat tacky plastic that encourages the adherence of organic matter. Additionally, when the materials are stored on the ground, they are typically picked up with a tractor bucket or fork attachment and loaded into a truck for shipping to the collection location. This handling method increases the organic contamination and reduces the value and recovery rates. Currently, there is a strong and growing interest in this previously ignored material stream as domestic processors are developing and improving technologies for processing, with processors south of the border doing the same. An Ontario based processor is already equipped to wash, process and pelletize this plastic film and has indicated a desire to acquire as much of the program film material as can be provided.

4.1.3. Sanitation Containers

HDPE based sanitation containers are a relatively easy recyclable plastic material due to the purpose of the product contained in them and usage practices. Typically sanitation and related containers are a concentrated liquid, which is mixed with water to achieve a desirable solution. This enables the users to rinse the drums and fully utilize the entire product contained therein. It also allows the drums to be presented clean and contaminant free for recycling. While a number of different facilities are able to receive and process these materials, there is one Ontario based facility which offered a higher price than others, and is also a licensed hazardous waste management company. This provides them with the resources and knowledge to safely manage these materials, regardless of their potential residue contamination.

4.1.4. Twine

Polypropylene twine is a difficult to manage material with very limited recovery options. This is due to a number of factors including the potential for organic contamination, the tendency of the material to bind and be difficult to handle and the small size of the pieces. However, in this case, the lack of competition for the reclaimable material has allowed a twine manufacturer to develop the critical mass of used twine necessary to facilitate a colour sorting, cleaning and reprocessing solution, specifically for this material. In order to ensure quality standards are met, the processor, located in the United States, does enforce a stringent list of acceptance criteria, which include requirements such as minimum weight per truckload, and contamination levels (less than 8% without penalty). When criteria are exceeded, there are monetary penalties applied and/or the paid for clean, weight of the material is reduced. The processor will also include transportation from a single point of generation in Ontario, in the price they pay for this material.

4.1.5. Greenhouse and Nursery Material

This mix of PP, PS and PE materials can be somewhat problematic to segregate. The difficulty is that offshore manufactured plastics do not necessarily conform to labelling requirements which include the appropriate plastic category stamped on the underside of the container. This prevents users from being able to sort and stream the containers correctly. A processor located in the United States has the optical sorting equipment necessary to be able to quickly and effectively separate dissimilar materials from each other and still retain value in the streamed product for its clients. These materials would still be required to be baled in order to maximize transportation efficiencies when sending loads longer distances to US processors.

4.1.6. Cardboard – OCC

This waste stream is the most recycled and easily managed waste stream in the agricultural packaging mix. Ontario is also fortunate to have ready access to a number of mills for reprocessing this feedstock into new products. Of particular value is the “long fibre” quality of the heavy duty cardboard typically used for agricultural product packaging, as opposed to domestic products, which are packaged in Asian manufactured cardboard containers. This material is typically short fibre, low strength and of very little value to recyclers.

Mills require cardboard to be delivered in a baled format in order to receive higher values and facilitate ease of handling and management. Mill rates for OCC tend to float on a monthly, market cycle and have seen very strong demand under good economic conditions, particularly as the price of virgin fibre increases significantly. By ensuring that poor quality fibres materials such as boxboard and laminates are kept out of the OCC collection stream, revenues can be maximized in the Ontario market and mills will pay a premium for this high grade material.

4.2. Revenue Model for the Processing of Recyclable Waste Streams

There are three main components to the revenue model for processing the above waste streams, and are as follows:

- overhead contribution – such as program development, management, and administration
- transportation costs to the processor, and,
- revenue from recycling

4.2.1. Overhead Costing

Overhead cost contributions are in line with those of the non-recoverable waste stream sub group. They are represented in this section due to the need to not only administer and develop a substantial collection and recycling program, but also as a result of the need to focus particularly intensely on creating awareness, education, developing support and motivating stakeholders to participate and grow the program. While the primary collection seasons occur during the months of April – June, with a secondary season occurring from August through October, there remains substantial work to be undertaken during the less busy periods. Table 25 reflects the overhead cost breakdown for the recyclable materials recovery program. Overhead revenue costs closely reflect the model recommended in the 2010 eBiz report entitled Collection and Disposal of Agricultural Pesticides and Animal Health Products in the Great Lakes Basin.

Table 25 – Recyclable Material Stream Overhead Costs

Depot Recyclables Collection Overhead Cost Center	**Cost**
Leadership and Administration	$120,000
Communication and Promotion	$72,000
Travel and Related	$24,000
Depot Cost Estimate – annual	**$216,000**

Leadership and administration costs include one full time equivalent FTE $75,000 for a leadership role and one FTE for administration. Communication and promotion costs were allocated in the amount of $4,500 per site area on an annual basis and included site specific materials such as signage, and literature in addition to publication advertisements and other media as available. Travel and related costs were estimated at $1,500 per site and included staff time and travel related expenses.

4.2.2. Transportation Costs

Pickup of finished, baled material and delivery to the end processor is intended to be performed on a milkrun basis. This is the most effective way of eliminating handling expenses and minimizing the cost of getting the material to the processor. A typical pickup would involve a 53 foot long flatbed tractor trailer loaded with 27 bales, or approximately 20,000 kg of material, being shipped directly to the processing site. An estimate of transportation costs has been done using commercially available carriers with a minimum and maximum volume range of material which is potentially recoverable for recycling destinations.

Table 26 – Total Recyclable Transportation Costs

Waste Stream	Recovery		Price Per Trip	# of Trips Per 20,000 KG		Cost	
	Min.	Max.		Min.	Max.	Min.	Max.
Greenhouse Film	27	172	$1,400	2	9	$2,800	$12,600
Silage Film and Bale Wrap	240	1,560	$1,000	12	78	$12,000	$78,000
Sanitation Drums, Jugs, Pails	112	725	$1,000	6	37	$6,000	$37,000
Twine	53	345	$800	3	18	$2,400	$14,400
Greenhouse and Nursery PP (mix of PS & PE also)	57	367	$1,400	3	19	$4,200	$26,600
Cardboard – OCC	478	3,107	$900	24	156	$21,600	$140,400
Total Transportation Costs						**$49,000**	**$309,000**

Depending on the volume of material recovered, transportation costs vary greatly. OCC volumes will drive the bulk of transportation expenses and comprise 45% of transportation costs under both a low and high recovery model.

4.2.3. Processing Revenue

Revenue streams from the processing of recyclables have been estimated using a minimum, recovery rate of 10% and a maximum recovery rate of 65%. Select markets have been identified which represent an optimum process for handling these materials with both the greatest environmental benefit and revenue potential. These revenue streams are based upon available market rates and market interest as of November 2011. At the request of Steering Committee members, specific end processing market identifications have not been used, in order to protect end market relationships and competitive information.

Table 27 reflects the different tonnages of materials that could be expected through the proposed agricultural waste diversion program. The general destination of end processors is also indicated.

Table 27 – Processing Opportunities for Recyclable Waste Streams

Waste Stream	Total Tonnage	Recovery Tonnage		Processor
		Min. 10%	Max. 65%	
Greenhouse Film	265	27	172	United States
Silage Film and Bale Wrap	2,400	240	1,560	Ontario
Sanitation Drums, Jugs, Pails	1,115	112	725	Ontario
Twine	530	53	345	United States
Greenhouse and Nursery PP (mix of PS & PE also)	565	57	367	United States
Cardboard – OCC	4,780	478	3,107	Ontario

Revenue from the sale of recyclables is dependent on a number of economic factors including the demand for virgin feedstock materials in the market, the supply of recyclables to the market and the ability of the market to convert the feedstock into saleable raw materials. Agricultural plastic is undergoing a high degree of attention and focus in the recycling markets as processors are constantly adding broader capabilities to handle unique material properties (eg. stringy nature of bale wrap), the organic contamination levels of agricultural films and twine and the mixed nature of greenhouse pots trays and other related materials.

The following table indicates the best market rates for the recyclable materials under consideration. Table 28 data is based upon a November 2011 snapshot of competitive market rates and provides a solid indication of revenue streams based upon recovery tonnage variances.

Table 28 – Recyclable Waste Stream Revenue

Waste Stream	Recovery Tonnage		Price Per Tonne	Revenue	
	Min. 10%	Max. 65%		Min.	Max.
Greenhouse Film	27	172	$396	$10,692	$68,112
Silage Film and Bale Wrap	240	1,560	$99	$23,760	$154,440
Sanitation Drums, Jugs, Pails	112	725	$500	$56,000	$362,500
Twine	53	345	$286	$15,158	$98,670
Greenhouse and Nursery PP (mix of PS & PE also)	57	367	$110	$6,270	$40,370
Cardboard – OCC	478	3,107	$207	$98,946	$643,149
Total Estimated Revenue Potential			*As of Nov 2011	**$210,826**	**$1,367,241**

Processing rates demonstrate a volatility which will be both economically driven and also market driven. During stable market conditions, as raw material input costs increase for paper pulp and oil production, the recycling markets will continue to remain strong and move higher volumes of material. This is principally due to the tendency of producers to try and minimize production costs in an effort to maintain margins.

However, despite the tendency for strong demand and readily available supply, the potential for unpredictable economic events with significant global market impact should not be discounted. Should the current unsteady financial markets readjust as they did in 2008, revenue streams from recyclables could quickly change to cost centers as commodity prices tumble in conjunction with decline in demand.

4.2.4. Recyclable Agricultural Waste Processing Revenue Summary

Table 29 – Depot Processing Revenue Summary

Depot Recyclables Processing Revenue Summary	Cost	
	Min.	**Max.**
Depot Overhead Cost Estimate - annual	($216,000)	($216,000)
Total Transportation Costs	($49,000)	($309,000)
Total Estimated Revenue Potential	$211,000	$1,367,000
Net Program Revenue (Loss)	**($54,000)**	**$842,000**

4.3. Economic Benefits of a Collection and Processing Program

While the implementation of a stewardship based collection and processing program for plastic, paper fibre and animal health products will benefit the environment in a number of positive ways, there are also economic spinoffs to the development of this program.

Employment increases are twofold and occur in the areas of staff for the Program Leadership and Development, and also Collection. While there will be increased volumes sent to recycling facilities for processing, is not expected that these additional volumes will require an increase in pre-existing facility capacity limits or employment.

Table 30 indicates expected employment increases as a result of the implementation of a collection and processing program.

Table 30 – Expected Employment Increases

Expected Employment Increases	FTE Staff
Event Based Program	
Leadership and Management	1/3 x $75,000
Administration	1/3 x $45,000
Depot Based Program	
Leadership and Management	1 x $75,000
Administration	1 x $45,000
Collection Services	
Baler Drivers	4 x $45,000
Baler Helpers	4 x $35,000
Leadership and Management	1 x $75,000

Total estimated full time staff equivalent positions are approximately twelve positions, and range from two mid-level management positions for program and operations administration to two administrative and eight labour positions.

4.4. Collection and Processing Program Financial Summary

A stewardship program designed to collect and responsibly manage all of the materials cited under the risk assessment portion of this study would be run at a net cost to a system operator, despite offsetting revenues from the higher value streams in the recycling component of the program.

A key consideration in the total cost analysis of this system is that any revenue from the management of these materials is highly dependent on very uncertain commodity markets which are currently operating at the higher end of the standard price range. As discussed earlier, any market corrections or swings have the potential to send $/tonne rates falling and quickly convert revenues into costs, or at the best, neutral revenues.

Table 31 presents a summary of the costs and revenues from the various disposal and recycling approaches for handling non-regulated recyclable and non-recyclable materials.

Table 31- Collection and Processing Financial Summary

Non-Regulated - Recyclable and Non-Recyclable Materials Program Cost Summary	**Cost**	
Processing Material Recovery Range	**Min. (10%)**	**Max. (65%)**
Non-recyclable waste items – (Cost)	($469,000)	($1,114,000)
Recyclables waste items - Net Processing Program Revenue (Cost)	($54,000)	$842,000
Collection and Processing Program Cost Summary	**($523,000)**	**($272,000)**

It is clearly evident from the cost projection information provided above that a stewardship based, agricultural waste management program would require strong financial, steward support. Based upon the size of financial obligation under this type of program, stewards would need to be committed to properly launching, developing and growing this program as a component of their business model.

One of the key success factors in the voluntary pesticide container management program run by CleanFARMS is the unwavering commitment and uncompromising approach to the best practice operations of a stewardship program. For a similarly targeted program to succeed within the plastic, paper fibre and animal health product categories, a comparable level of dedication will be essential.

As previously discussed, the above cost summary only includes the materials which have been absolutely classified as non-regulated materials. Suspect or potentially regulated materials have not been included.

5. Product Stewardship

Within Ontario, there is currently significant opportunity for the diversion of vast amounts of recyclable agricultural waste through the implementation of an agricultural product, industry stewardship plan. Table 32 provides a breakdown of the agricultural waste volumes that require a stewardship program.

Table 32 – Agricultural Waste Requiring Stewardship Management

Waste Stream	Material Description	Province Wide Management System	Covered by Ontario EPR Regulation?	Estimate Volume (in Tonnes)
Plastic				
Film Plastic – incl. Silage/Bale Wrap	LDPE	NO	NO	3,510
Woven Bag Plastic	PP	NO	NO	490
Twine Products – incl. Net Wrap	PP	NO	NO	1,227
Plastic Jugs, Pails and Drums – Pesticide	HDPE	YES	NO	275
Plastic Jugs, Pails and Drums – Sanitation Products	HDPE	NO	NO	1,115
Plastic Jugs, Pails and Drums – Oil	HDPE	YES	YES	360
Greenhouse and Nursery potted plant insets, trays pots etc.	PP, PS	NO	NO	505
Potted Plant Sleeves	PP, LDPE, HDPE, PS	NO	NO	60
Paper Fibre				
Unlined Paper Bags – seed	Paper fibre	NO	NO	400
Lined Paper Bags -incl. laminates, feed bags	Paper fibre and plastic	NO	NO	240
Cardboard Boxes	Paper fibre	YES	YES	4,780
Cardboard Boxes Waxed	Paper fibre, coated	NO	NO	1,050
Animal Health Products				
Animal Medications	Pharmaceutical	NO	NO	1
Glass Bottles	Glass	NO	NO	1,100
Plastic Bottles	HDPE	NO	NO	67
Sharps	Bio-haz	NO	NO	9
Packaging - bags, plastic bottles, inserts, tubes, boxes	Mixed Stream	NO	NO	2

While certain segments have developed, functioning stewardship programs in place, or receive overlap service through collection programs such as the Blue Box curbside program, there is currently not a formalized framework or requirement for agricultural product stewards to be part of an EPR system.

5.1. Current Stewardship Programs in Ontario

Currently the province of Ontario has a series of programs in place which are designed to administer and finance environmentally sound end-of-life management of waste materials. The following table summarizes existing provincial programs, some of which target materials generated on farms in the province. Some of these programs are voluntary rather than mandatory.

Table 33 – Current Stewardship Programs

Material	Stewardship Organization	Collection	Financing
Packaging, paper materials, including boxboard, cardboard, paper laminates, newspapers and magazines, containers, aluminum cans etc.	Stewardship Ontario	Material is collected through a municipal curbside collection system and through some municipal depots in smaller communities	Financed by product stewards
Scrap Tires	Ontario Tire Stewardship	Material is brought to collection sites by users (includes tractor tires)	Financed by product stewards
Used Oil, Oil Filters and Containers	Stewardship Ontario	Material is generated at retail locations and brought to collection sites by users	Financed by product stewards
Electronic Items	Ontario Electronic Stewardship	Material is brought to drop off depots and retailers	Financed by product stewards
Obsolete Pesticides and Empty Pesticide Containers. VOLUNTARY	CleanFARMS™	Material is brought to collection sites by users where it is prepared for safe disposal (obsolete pesticides) or recycling (containers)	Financed by product stewards

5.2. Potential Stewards as Identified During the Waste Characterization Study

The lists of manufacturers, first importers and retailers included in this report were previously compiled by supporting project studies and included internet searches, discussions with those contacted to supply data for this research and from existing documentation. The following results are primarily from the BlackSheep Study and the 2cg report on plastics, paper fibres and animal health products.

5.2.1. Plastic

The list of product stewards in this section has been suppressed from publication to protect the privacy of Stewards. Steward information is on file and available to be used for the development of a stewardship program.

5.2.2. Paper

The list of product stewards in this section has been suppressed from publication to protect the privacy of Stewards. Steward information is on file and available to be used for the development of a stewardship program.

5.2.3. Animal Health Products

The list of product stewards in this section has been suppressed from publication to protect the privacy of Stewards. Steward information is on file and available to be used for the development of a stewardship program.

5.3. Stewardship Options

There are several options for a stewardship program to manage the wastes produced on Ontario farms. While all of the following options have a similar end goal; which is to encourage and support the achievement of effective environmental stewardship within a specific category of agricultural wastes, there are notable differences such as the level of user commitment, strength of motivational factors, and legislative support.

5.3.1. Mandatory Option

A mandatory legislated program would cover products not currently under the stewardship regulations such as paper fibre bags, plastic packaging (e.g. twine, bale wrap) and animal health products. A number of packaging materials are already covered by the Blue Box program. A mandatory option would obligate all product "stewards" (generally defined as brand owners or first importers) to develop and finance an end-of-life management plan. Stewards may opt to internalize these costs into their product price or may choose to apply the cost on a unit basis at the point of sale (similar to the "eco-fees" being charged on items like tires, motor oil, and oil filters).

For this option, an organization such as CleanFARMS could represent the stewards and act as the central 'clearinghouse' for program management, funds distribution, accountability and reporting.

Mandatory EPR programs have an increased success rate when they are supported by other policy instruments such as eco labelling on packaging and disposal/burning bans for the waste products. This support would be particularly valuable in the agricultural sector as on farm burning is not an uncommon practice.

This option has the highest likelihood of success since it ensures that there are sufficient funds available to operate a cost effective program for the collection, transportation and recycling/disposal of the waste materials. Furthermore, since all stewards are obligated to pay their 'fair share' into the program, no producer can have an unfair advantage in the marketplace by choosing to opt out.

The challenge of this option, as it exists for any stewardship program, is to capture all of the responsible stewards including those of imported products, whether that importation occurs directly at the farm level, at the retail level or in the case of animal health products, at the professional services level. It is acknowledged that stewards operating under a mandatory program are not going to be satisfied with covering the costs of product and packaging derived from non-stewarded materials.

A mandatory program may also attract the participation of non-obligated stewards since they may not want to publicly appear to be "uncommitted" to sound environmental management principles through a lack of participation.

5.3.2. Voluntary Option

An alternative to a mandatory stewardship program is one that is completely voluntary. Again, an organization like CleanFARMS could design and operate a collection program for any number of designated waste agricultural materials. CleanFARMS brings to bear the requisite experience required to operate both a provincial and national, voluntary stewardship program. During the development of the national Pesticide Container Management Program, CleanFARMS has had to deal with the challenges posed by own use and imported product and packaging. This program would be paid for with fees charged to producers who agree to act as 'stewards' voluntarily.

A voluntary program could be implemented in stages where it would begin with some of the designated materials and then phase in others over time. The advantage of creating a staged program in this fashion is that it would allow the stewards to put the infrastructure in place to collect, transport, process and establish recycling markets for the initial materials, and then phase in others as the program grows.

In the case of a voluntary program, it may be even more important to support the plan with policy instruments such as eco labelling and bans on improper disposal in order to increase the chance of program success. It is acknowledged that voluntary stewards are not going to be satisfied with covering the costs of product and packaging derived from non-stewarded materials.

With a voluntary program, industry is able to design the program the way they want with limited prescriptive legislated requirements. This can reduce the overall cost for stewards by minimizing the monitoring and reporting requirements of the program. However, it should be noted that some producers may choose to opt out of this type of program, which would have the effect of creating an unfair economic disadvantage for those that decide to participate. This may be one of the key drivers behind the mandatory legislative requirements of many of the Canadian stewardship programs.

5.3.3. Ban Only Option

In Germany, landfilling of all agricultural wastes is banned and, while incineration of these materials is theoretically an option, it is prohibitively expensive (i.e. tipping fees can reach levels of over $250 CAN per tonne). Consequently, there are strong incentives to put stewardship programs in place to collect these materials and maximize the quantities that are either recycled or disposed of in a manner so that incineration and landfill becomes the disposal approach of 'last resort'.

The challenge with a landfill ban is that it requires both public and political support to make this option a key policy instrument. A ban must also be enforced in order to be effective. Municipalities and industry would be required to make an effort to enforce a ban at public and private landfill sites, which may make this policy option more difficult to implement. It would, however, be a useful component of a longer term strategy to deal with agricultural waste.

The same prohibition must be implemented for landfills, and particularly rural landfills who still take advantage of onsite burning. It was noted during the research for this project that there still exist landfills that employ burn pits and Saturday burn practices.

5.4. Factors Affecting Stewardship Options

Of particular concern with the application and development of either a new mandatory or voluntary Stewardship Program in Ontario is the challenge of identifying and engaging stewards who import direct to consumers in the province.

The Canadian Animal Health Institute members are very concerned with this invisible retail segment as it would allow importers who ignore stewardship responsibilities to avoid paying their fair share of steward fees and instead allow them to offload these costs to their competitors who would be registered Stewards in Ontario. This non-approved market has been estimated to be as large as $100 million nationally in 2007 (IFAH study "Benchmarking the Competitive ness of the Canadian Animal Health Industry"). CAHI asserts that importers, or those who employ products under the own-use provision, in addition to veterinary professionals who prepare formulations of medications, must be charged some type of disposal fee or contribute to the costs of operating a stewardship program to ensure fairness to all product stewards who meet their EPR responsibilities.

5.4.1. Industry Contributions

A variety of opportunities exist for the contributions of industry to supporting and leading stewardship programs. The design, implementation and administration of a stewardship program are challenges that require the experience and knowledge of the key success factors that maximize participation, diversion and minimize steward cost. Across industry categories, an effective stewardship program will need industry to provide:

- Education – to develop a knowledgeable and informed consumer base who understand the need for the program
- Commitment – to the principles of EPR and maximizing diversion so that the consumers ensure the success of the program through their support and participation. This will also be reflected in other, less visible aspects of the company such as product design and impact on the environment.
- Leadership – in promoting responsible behaviour in actions and in day to day operations
- Promotion – expansion and growth of the program to reach all potential users and stakeholders is most effective when delivered from the grassroots upward. Industry speaks to its consumers at the most fundamental levels in terms of what products they consume and how they are used.

Industry has the ability to wield and leverage brand influence to make real positive changes via a stewardship program.

A number of factors impact the ability of a stewardship program to accurately assess the cost requirements and program operational needs for the comprehensive disposal of broadly defined animal health product waste. The structuring and organization of the animal health product categories and their associated potential environmental risks are a critical step needed for the design of a cost effective management system. Once the animal health product industry can agree on how to communicate the risk messages, on a categorical basis, to their user base, they can then work towards developing awareness, changing attitudes and increasing best practices waste management behaviors.

From a legislative perspective, animal health product industry groups must clearly convey the need to both their own members and to their Provincial and Federal regulatory agencies, of the need for a "Clear Language" labelling program. To further complicate matters is the significant volume of products which are imported from international sources. In the 2010 CAHI report on animal health products sold in Ontario by CAHI members, it was indicated that "Made-in-Canada requirements for packaging/disposal of products could result in decisions to not bring these important tools to Canada..." (CAHI 2010)

Admittedly, there are considerable approval hurdles to overcome with any prospective packaging labelling change; however, it is clearly evident that change must occur and that industry is best equipped to lead those changes.

5.5. Expanding Stewardship Development

Stewardship program development requires a number of key components in order to maximize the potential for success. An effective program requires:

- the identification of a robust list of stewards
- the development of a strong impetus to promote participation
- the design of an efficient collection process – sustainable, broadly based
- the design of a cost effective collection and processing system

While the above list is not intended to be a comprehensive summation of key success factors of a stewardship program, the components indicated are critical to an easily administered, sustainable and cost effective Extended Producer Responsibility program.

A typical extended producer responsibility (EPR) stewardship plan usually includes the following key items:

- Clear definition of the stewarded product;
- Targets for collection (accessibility and recovery targets);
- Promotion and education for all stakeholders (stewards and consumers);
- Financing by the stewards;
- Reporting of results.

5.5.1. The Need for a Mandatory Stewardship Program

Addressing the unmanaged products in this study through EPR and stewardship programs can be accomplished either through voluntary schemes or mandatory schemes. Across Canada and throughout OECD countries, practice has shown that for EPR stewardship schemes to be successful, backstop regulation making the programs mandatory appear to be the only way to achieve reasonable success. There are, however, some exceptions and the CleanFARMS pesticide container and obsolete pesticide collection program are two.

Many exceptions, though, are not easy to find. It doesn't seem likely that a voluntary program will work for most of the products studied as it requires changes in industry behavior, consumer behaviour and resource commitment to making those changes occur.

Fortunately, this study has shown that there are collection and processing options available for virtually all of the products identified - no technical barrier exists to manage most of these products. The challenge in moving forward with a broader stewardship model is that new infrastructure and new collection programs will be required.

In the current form, as shown in the farmer surveys, many of these products are either burned or buried. In some cases this occurs at the farm level, while in other cases, it is at the municipal landfill, even though there is a charge to dispose of waste products.

Managing these products through stewardship means that utilizing recycling and safe disposal will add costs to the stewards of the products. These costs will typically be passed on to the consumers of the product either in added fees at retail or incorporated in the selling price of the product.

While there are benefits to recycling and safe disposal that far outweigh the added costs of the program, these weren't calculated as part of this study. It should be noted, however, that there is an overwhelming majority of the farmers surveyed in this study that want to manage their wastes in an environmentally responsible manner. By introducing a mandatory program, plastic, paper fibre and animal health product manufacturers that serve the agricultural industry will be required to align their practices and business models to support and promote a sustainable end-of-life management stewardship program for all of the waste materials their products generate.

Appendix 1 – Collection and Disposal of Unwanted Agricultural Pesticides and Animal Health Products in the Great Lakes Basin

Collection and Disposal of Unwanted Agricultural Pesticides and Animal Health Products in the Great Lakes Basin, Jan 29, 2010, prepared by eBiz Professionals Inc.

Summary

This feasibility study identifies and details program options for the collection and disposal of unwanted pesticides, animal health products and sharps, used on farms. It investigates farmers' current disposal practices, in addition to their attitudes and behaviours towards collection and disposal programs, leading to recommendations of the best program options. The study team included a Working Group of well-advised senior members of the industries involved in the sale and distribution of these products.

The report identified that a successful program must:

- have a high farmer participation rate
- remove a high percentage of the targeted waste
- have a reasonable cost and effort
- demonstrate responsiveness and caring towards the environment

Consideration is also given to the fact that Ontario is proposing to use the principals of Extended Producer Responsibility (EPR) as the basis for their waste diversion framework.

Multiple research and evaluative techniques, such as interviews, surveys, and focus groups were cumulatively employed to determine the optimal collection and disposal program solution. Existing industry programs and best practices were also reviewed across Canada and internationally.

From its research, the team conducted both surveys and focus group research with farmers to determine how Ontario farmers view the management of these waste streams and how they might respond to future options for doing so. Approximately 90% of farmers described the safe disposal of pesticides and animal health products as "the right thing to do", want to demonstrate that they are environmentally responsible, and believe that safe disposal will make their farm operations safer. Farmers strongly believe that proper collection, storage and disposal of pesticides and animal health products is an important part of how they manage their farms. They acknowledge that preventing the release of these products into the environment positively impacts the water quality of the Great Lakes.

Research also determined that farmers are managing the waste generated on their farms, using a variety of resources including dealer blitzes for pesticides, veterinarians' removing animal health products and sharps, on-farm storage, collection services, and on-farm disposal for all three waste streams. Farmers do not want additional paperwork or more regulations and question why this waste cannot be handled in municipal facilities. They do agree that sorting unwanted products and taking them to a disposal location is not a significant barrier to the disposal of unwanted pesticides and animal health products. Dropping product off at the purchase location is the preferred option for 62% of farmers, while 20% of farmers surveyed wanted these products picked up on-farm, with 14% preferring the municipal option.

Thirteen potential waste collection and disposal options analyzed in this study were evaluated with respect to frequency, location and cost. The following two approaches are recommended:

1. A three-stream blitz (obsolete pesticides, obsolete animal health products and used sharps) operated every four years, employing the CropLife Canada model and brand;
2. Strategically situated return depots throughout the province for an animal health products and sharps collection and disposal program, should the three-stream approach not be accepted.

The Ontario government appears willing to assist in funding initial program design activities, while applying the principles of EPR will ensure the participation of the pesticide and pharmaceutical

industries. Further-more, farmers are willing to pay a portion of the collection and disposal fees of the products they use.

Consideration of the enforcement of a training and education program for the handling, storage and safe disposal of animal health products and sharps is recommended, similar to the existing, successful mandatory pesticides certification program, providing farmers with a consistent, parallel experience.

Appendix 2 – Primer for Extended Producer Responsibility

Primer for Extended Producer Responsibility, Jan 19, 2011, prepared by CM Consulting Inc.

Summary

Across Canada, provincial governments are rapidly implementing new regulations in various sectors, including the agricultural sector, to ensure more waste materials are recycled. These regulations are based on the principle of Extended Producer Responsibility or 'EPR' and are intended to: increase recycling of wastes into valuable new products, ensure the safe disposal of non-recyclable waste, and shift the responsibility of waste management from municipalities and taxpayers to the producers (or the first importers of a product in a region), thereby designating them "stewards" of the product.

EPR requires producers to be physically and financially responsible for end-of-life management of any waste that is generated from the use of their products. This provides producers with an incentive to consider end-of-life waste management in the design process. In the agricultural sector, EPR manageable wastes include packaging, such as empty pesticide containers, bale wrap and twine, and other products, such as used tires, vaccines, pharmaceuticals, sharps, and other non-organic wastes. When improperly disposed of, these wastes create environmental and energy conservation concerns.

To determine the size and scope of Ontario's agricultural sector waste, CleanFARMS™, a not-for-profit industry stewardship company, has completed a series of waste characterization studies in conjunction with the Ontario Ministry of Agriculture, Food, and Rural Affairs with funding assistance from Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem and the Canadian Animal Health Institute.

Since 2002, Waste Diversion Ontario has had the authority to establish waste diversion programs for designated wastes which are operated and paid for by industry-funded organizations who recover operating costs directly from the appointed stewards. The Ontario government is considering options to support further waste diversion, including disposal taxes and disposal bans. While regulations are the primary drivers of these programs, voluntary programs do exist and operate effectively.

One example of a voluntary EPR program is the CleanFARMS™ empty pesticide container recycling program. All costs for the program are borne by the product manufacturers or importers with 63% of all pesticide containers sold in Canada being recovered annually. This is in contrast to a 2010 Ontario Auditor General's report which cites a total waste diversion rate in the industrial sector of only 12%. The CleanFARMS™ empty pesticide container recycling program has prevented more than 68,000 tonnes of greenhouse gas emissions, equal to taking more than 13,000 cars off the road. Non-recyclable materials, such as obsolete pesticides, were also collected and safely disposed of through a separate CleanFARMS™ program.

A well-designed EPR program for agricultural waste can benefit farmers in several ways. First, by shifting the responsibility of certain product or packaging waste to the stewards, farmers can eliminate key disposal challenges. Second, Ontario farmers can have confidence that these waste products are being handled in an environmentally sound manner. Finally, by avoiding emissions, our air, land and water resources will be protected for future generations.

To ensure the success of these programs, members of Ontario's agricultural sector must help shape public policy for new EPR programs in their industry. This includes manufacturers, retailers and

generators of specific wastes (i.e. farmers). Ontario farmers and product stewards play a vital role in laying the groundwork necessary to help guide decision-makers in developing effective programs with the most appropriate funding models, to meet the needs of the agricultural sector and achieve significant environmental benefits.

Appendix 3 – CleanFARMS Ontario Farmer Survey

CleanFARMS Ontario Farmer Survey, January 19, 2011, prepared by Black Sheep Strategy Inc.

Summary

Completed in November, 2010, this quantitative telephone survey randomly sampled 328 farmers from across Ontario, with the purpose of gaining insight into the farm wastes they generate, the disposal methods they employ, and their behaviours and attitudes related to agricultural waste and recycling. The results will be used to develop and evaluate future collection and recycling programs. The survey did not address other metrics such as waste volumes or the potential toxicity of wastes.

Two-thirds of respondents were located in Southern and Western Ontario, almost one-third were located in Central and Eastern Ontario, with the remainder located in Northern Ontario. The sample included approximately 37% of growers with primarily crop operations, 36% with mixed crops and livestock, 18% with primarily livestock, and the remaining with horticultural operations, fruit crops, greenhouses, nurseries or other. The average acreage within the sample was 362 acres.

Farms generate a wide variety of waste materials and have historically relied upon landfilling and onsite burning as preferred disposal methods for managing a significant number of these waste streams. The following table provides a clear indication that there is substantial opportunity for diversion and recycling within this population segment. More optimal disposal methods for waste containers and other products include re-use, recycling, and returning waste to the supplier, retailer or collection sites.

Waste Material	Farms With Waste [%]	Disposal Method Burning	Disposal Method Landfilled
Plastic oil or antifreeze containers	76%	15%	25%
Empty seed bags	63%	57%	11%
Plastic wrap or packaging	56%	20%	40%
Cardboard packaging (from other ag products)	54%	31%	7%
Cardboard packaging (from pesticides)	50%	44%	8%
Twine or net wrap	36%	46%	39%
Sharps or needles	31%	2%	35%
Empty feedbags	31%	28%	23%
Plastic wrap from hay or silage bags	24%	26%	40%
Empty plastic livestock disinfectant containers	21%	10%	20%
Unwanted animal health products or pharmaceuticals	19%	9%	27%
Styrofoam packaging	17%	14%	52%

The type of waste generated on a given farm can be broadly correlated to geographic region and farm type. Eastern and Northern Ontario farmers generate more livestock-related waste products including sharps and bale wrap. Central Ontario respondents generate more machinery-related wastes such as antifreeze, oil and related containers. This suggests that specific diversion programs targeting a given region or farm type may prove effective.

Farmers are most likely to find out about recycling or safe disposal programs from farm newspapers, farm magazines, crop input retailers, and other farmers. In fact, 92% of farmers indicated an awareness of a container collection and recycling program. In terms of making use of this program, analysis shows that the closer the generator is to the drop off site, the higher the portion of containers returned. This is an important observation and likely relevant to other waste streams.

Overall, farmers indicate a significant degree of engagement and concern regarding the safe disposal of agricultural waste products. However, over 50% agreed that while uncomfortable burning or landfilling certain wastes, they see no alternative. One in five farmers agreed that they had a lot of waste materials that they were unsure how to safely dispose of. Farmers have mixed feelings as to whether the agricultural industry is doing enough to ensure responsible waste disposal options for their products, with 17% of respondents disagreeing and 4% unsure.

Appendix 4 – Ontario Agricultural Waste Study – Waste Characterization

Ontario Agricultural Waste Study – Waste Characterization, March 2011, prepared by 2cg Waste Management Consulting Services

Summary

This study provides a waste characterization of non-organic agricultural waste, generated on-farm in Ontario. It focuses on packaging wastes and provides an overview of sharps waste generation. The data presented is preliminary, baseline data and the intention is to use this information to assess the feasibility and opportunity for the development of recycling and safer disposal programs for these products.

Information was acquired through extensive desktop research, analyzing other Ontario-based waste characterization studies, and field research, including interviewing subject matter experts and farm visits. This waste characterization was developed through a combination of the following methods: 1. Estimate of material consumption and waste generated by consumption; 2. Estimate of waste generated per unit of production; and 3. Existing farm waste generation data. The specific waste categories and sub-categories are listed as follows:

Plastic	Paper Packaging	Glass	Sharps
Film plastic (incl. bale/silage wrap, greenhouse film, mulch film, plastic bags) (LDPE)	Kraft paper bags (unlined)	Animal health products	Needles
Woven plastic bags, bulk bags (PP)	Kraft paper bags (lined)		Syringes
Twine (PP)	Corrugated cardboard (OCC)		Scalpels
Jugs, pails, and drums (HDPE)			Lancets
Pots, trays, inserts, flats (PP, PS, HDPE)			

An estimated 14,500 tonnes of non-organic waste is generated annually on Ontario farms, split primarily between plastic and paper packaging, with the small remainder comprised of glass and other wastes (including sharps). This value would be significantly higher, except that most key inputs (e.g. fertilizer, seed, feed) sold to farms are sold in bulk, and do not generate any non-organic waste at the farm. The largest contributor to plastic packaging wastes (6,912 tonnes/year) generated on-farm is low density polyethylene (LDPE), which is used for bale and silage wrap, fertilizer bags, grow bags, and greenhouse film. The largest contributor to farm generated paper packaging wastes (6,429 tonnes/year) is cardboard, which is used in a variety of applications including plant pots, inserts, flats, and liners. Glass and other waste, generated from animal health products contribute approximately 1,100 tonnes/year.

A mixture of landfilling, recycling, re-use and on-site burning are used to manage farm generated wastes. Both farmers and retailers are making efforts to avoid the landfilling of wastes, although there is still opportunity for an increase in diversion rates. 66% of Ontario's waste is non-residential, including farms, and of that, only 12% is diverted from landfill or incineration. One example of a widely adopted industry recycling program is the CleanFARMS™ 'Empty Pesticide Recycling Program', operated across Canada. Blue Box programs have also been used to divert some farms wastes (e.g. paper bags, jugs, pails) although it is unknown if steward fees have been paid for these waste materials.

There were essentially no recycling programs and limited recycling opportunities for LDPE bags,

polypropylene bags and other film, as well as unlined and lined paper bags, which tend to be landfilled and burned respectively. Some waste streams, such as jugs, pails and drums are included in a number of return-to-retail programs. However, return-to-retail programs were inconsistent and not available across the Province. Most animal health waste, including sharps, is removed from the farm by vets, though a small portion of sharps do get landfilled.

Based on 27 farm visits, it was noted that most farms had an Environmental Farm Plan and all farms visited had a genuine interest in managing their non-organic wastes in an environmentally responsible manner.

Appendix 5 – Waste Characterization Survey of Animal Health Products Sold in Ontario by Members of the Canadian Animal Health Institute in 2010

Waste Characterization Survey of Animal Health Products Sold in Ontario by Members of the Canadian Animal Health Institute in 2010, March 3, 2011, prepared by Canadian Animal Health Institute

Summary

Animal health products are a positive and necessary element of Canada's agricultural livestock industry. This study characterizes the waste from the following four sub-categories of animal health products: animal pharmaceuticals, biologics, animal pesticides and feed additives. The waste itself is divided into two categories: packaging waste and unwanted/expired product. The results from this study were incorporated into a larger waste characterization study which will be used to develop end of life management programs for a wide variety of agricultural waste streams.

The Canadian Animal Health Institute (CAHI) is the trade association representing the manufacturers and distributors of animal health products/medications in Canada. Canada represents 3% of the global market, a fact which must be considered in any animal health product stewardship program. Most major animal health companies are trans-national with priorities driven by larger international markets.

In Ontario, animal health products are federally regulated with provincial governments having a role in controlling product availability and distribution. Two exceptions are that veterinarians are allowed to prescribe non-licensed Active Pharmaceutical Ingredients (API's) and animal owners are allowed to directly import product from other countries (Own-Use Importations, OUIs). This unapproved market was estimated to represent $100 million in lost opportunity sales in the "Benchmarking the Competitiveness of the Canadian Animal Health Industry" report prepared by the International Federation for Animal Health in 2007. Creation of an animal health product stewardship program must address unused and expired product and packaging from the manufacturers, importers or users in the API and OUI markets. Development of a stewardship program must include a mechanism to properly manage all category products and collect related program fees.

Packaging requirements for animal health products is complex, as a result of regulatory labelling requirements and the need to maintain product integrity. The vast array of packaging formats also makes it difficult to predict waste volumes. Packaging includes outer cartons, product inserts, injectable bottles, single- and multi-dose containers, clamshell packaging and pressurized containers.

Current methods for disposal of the vessels for animal health products in Ontario are varied. Much of the waste (paper, boxboard, PE, PET, LDPE, HDPE and glass) could be recycled in typical packaging recycling programs, though it is also landfilled, stored or burned on-farm, returned to veterinarian, or collected and disposed of through municipal hazardous waste days, through medical waste disposal companies or through stewardship activities such as the 2009 Clean Farms™ collection.

Impact Vet, a Division of AgData Ltd., has developed and maintains a database which captures the sales data for 90% of the monthly sales of the animal health products sold in Canada to veterinary clinics. Expanding the database to include product packaging types allowed for the estimation of the total volumes of product and corresponding packaging waste requiring management in Ontario.

Inclusion of non-CAHI members, non-Impact Vet manufacturers, addressing imported (OUI) product and non-approved API use are factors that will need to be addressed to have a truly representative program.

Only medications left on-farm would qualify for a CleanFarms™ program. CAHI estimates that 100% of biologics and animal pesticides, 10% of feed additives and 80% of pharmaceuticals would be administered by veterinarians and/or farmers on the farm, thus qualifying for a CleanFarms™ program. Addressing unwanted or expired animal health products poses a challenge because product quantities are estimated to be low and difficult to predict. Farmers typically purchase, through a prescription, no more product than is required, however, occasions for unused product arise including animals dying before treatment is completed, contamination of product and expiration of product.

Appendix 6 – Landscape Ontario All Plastics Collection 2011

Landscape Ontario All Plastics Collection 2011, October 11, 2011, prepared by CleanFARMS™

Summary

This post-event report analyses the outcome of Landscape Ontario's 4th Annual All Plastics Collection Event, held from June 24th to July 5th, 2011 and overseen by the Canadian Nursery Landscape Association (CNLA).

The program was funded by the Canada-Ontario Agreement Respecting the Great Lakes Basin Ecosystem and OMAFRA's Great Lakes Program. This pilot project collection program was a coordinated effort between producers interested in waste plastic recycling and disposal, and the landscape industry, as represented by Landscape Ontario and the Canadian Nursery Landscape Association. It examined options for the collection of waste plastics and packaging from greenhouse, nursery and landscape industries, to support potential industry stewardship for waste plastic.

This event was offered without cost to the public and targeted over 73% of Ontario residents, specifically those who are not serviced by a municipal recycling program for pots and trays. This collection event received support from CleanFARMS™, Plastix Canada and Agricultural Plastics Recyclers (APR).

In total, over 18,000 lbs of horticultural plastic wastes were collected, a 10% increase over the previous year. This was the first year that retailers had their plastics collected on-site, versus having to bring them to a central location in Milton, Ontario. This resulted in the largest number of retailers participating, to date.

The event's success can be attributed to an increase in retailer collection locations and from the creative media campaign designed to develop awareness and drive traffic to participating retailers. These efforts resulted in exceptional coverage throughout local media.

The municipal recycling programs around the province vary greatly with regards to the acceptability of plastic flower pots, nursery trays and plant tags. Through a previous study conducted by CleanFARMS™, it was determined that only 18% and 27% of the Ontario population have access to nursery tray and flower pot recycling respectively. The acceptance of film products (soil and fertilizer bags) is even lower.

Collection of the plastics was facilitated by the participating retailers, as well as Plastix Canada and APR. The garden centres were responsible for promoting the event to their customers, collecting the plastic from consumers and organizing it by type. Plastix Canada and APR worked directly with the garden centres regarding the sorting and organizing procedures, and managed the logistics of getting the material to the processor.

A post-event survey received feedback from the 60% of participating garden centre retailers. The survey mad e the following recommendations:

- lengthen the collection event to coincide with the beginning of planting season in the spring, and run it through the end of July to allow sufficient time to generate more awareness of the program.
- ensure clear lines of communication with Landscape Ontario and the recycler.
- provide clear instructions on sorting and packing procedures, including those for unmarked plastic.
- ensure that the recycler picks up material and drop off receptacles in a timely, and accurate manner
- provide promotional material regarding the benefits of recycling, and ensure that the collection receptacles are in good repair and appropriate for outdoor collection.

Appendix 7 – Ontario Agricultural Waste Study: Measuring the Environmental Benefits of Recycling Agricultural Wastes

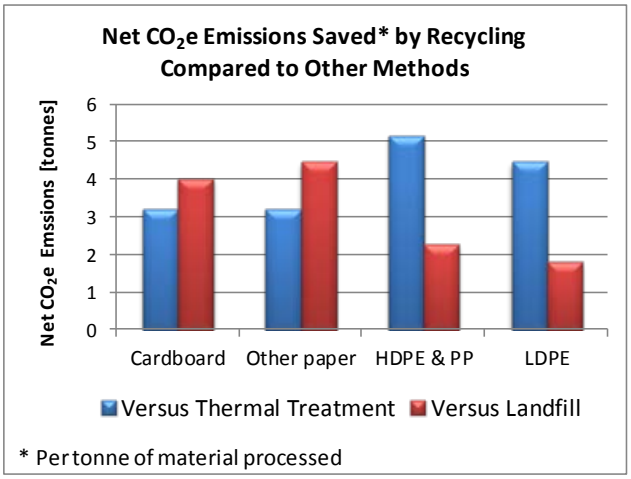
Ontario Agricultural Waste Study: Measuring the Environmental Benefits of Recycling Agricultural Wastes, August 8, 2011, prepared by CM Consulting

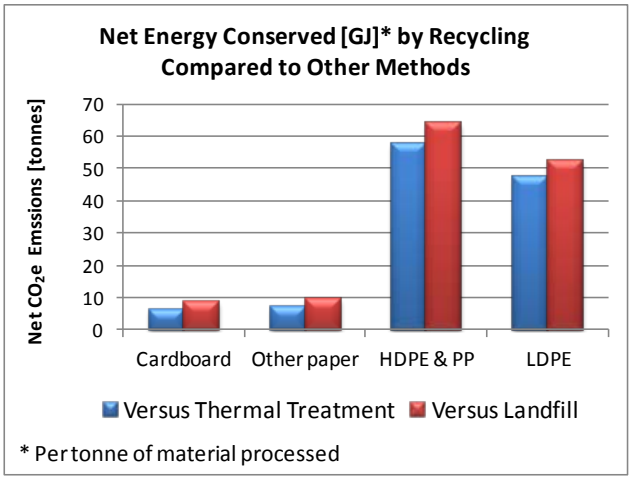
Summary

Every year in Canada, recyclable agricultural packaging materials made from plastic and paper fibre are landfilled or burned. These disposal methods result in health and safety hazards related to pollution, as well as energy conservation concerns. Recycling results in an overall reduction in greenhouse gas (GHG) emissions. Additionally, products made from recycled raw materials require significantly less energy than virgin resources since primary extraction and processing functions for the raw materials are avoided.

Environment Canada's Life Cycle Analysis (LCA) model has been used to measure the net benefit of end-of-life management options for cardboard and plastic waste. For agricultural wastes, such as plastic film, twine, bale wrap, drums and pails, paper bags and corrugated boxes, the benefits of recycling versus disposal, i.e. landfill or thermal treatment, are significant.

The following graphs illustrate the impact of recycling versus more traditional waste management options, such as landfill and thermal treatment (i.e. incineration which burns materials in a controlled environment). The calculations include the upstream benefits (avoided primary extraction and production stages from recycling) and the avoided downstream impacts (landfill or thermal treatment avoidance). The first graph illustrates the carbon dioxide equivalent ($C0_2e$) emissions saved (measured in tonnes), and the second graph illustrates the net energy conserved (measured in GJ), calculated from recycling one tonne of each of the types of materials found in the agricultural packaging material stream.





With respect to energy conservation, recycling paper and plastic agricultural wastes conserves up to 10 times more energy than thermal treatment. Recycling 100 tonnes of agricultural waste plastic conserves the equivalent energy of up to 1000 barrels of oil when compared with traditional landfill practices.

It should be noted that large volumes of farm waste is also buried or burned on-site, a practice which possesses the potential to produce significant emissions, including dioxins and furans, fine particulate

matter (PM), and heavy metals. Environment Canada suggests that the uncontrolled burning of garbage on-site may be the largest remaining single source of anthropogenic dioxins.

Appendix 8 – Ontario Agricultural Study: Environmental Impacts of Open-Burning Agricultural Plastics

Ontario Agricultural Waste Study: Environmental Impacts of Open-Burning Agricultural Plastics, July 2011, prepared by Sonnevara International Corp.

Summary

Canadian farmers regularly and increasingly use a variety of plastics, including baler twine, bale wrap, and pesticide containers. A comprehensive program operated by CleanFARMS exists nationally to manage waste pesticide containers, but no similar program exists for other farm plastics. These materials present a serious disposal challenge to farmers across Canada.

On-farm burial and open burning of waste plastics remains a common practice on Canadian farms, resulting in both air pollution and resource conservation concerns. Recycling these plastics typically provides the largest net environmental benefit. Recent surveys and other reports suggest that farmers burn up to 80% of common agricultural plastics while sending a large portion of the remainder to landfill. Almost 50% of farmers are either unaware of the risks of burning plastic agricultural waste or do not believe they have any alternative.

Open burning of agricultural plastics can lead to the release of many air pollutants and hazardous by-products. On-site burning of waste (e.g. burn barrels) has been identified as the largest source of dioxin emissions in Ontario, leading to serious health concerns, even when exposure is only to very small quantities. If half of the agricultural plastic used annually in Ontario is handled through on-site burning, it has the potential to contaminate 75 million kg of soil, or approximately 7,500 truckloads.

Issues Related to Open Burning of Agricultural Plastics

Pollutants Released	Dioxin and Furan Health Concerns	Areas Threatened	Mode of Human Exposure
Carbon monoxide	Carcinogenic	Humans	Direct inhalation
Heavy metals	Endocrine disruption	Aquatic species	Ingestion of contaminated plants
Dioxins	Heart disease	Wildlife	Ingestion of contaminated animals
Furans	Cognitive disabilities	Soil Fertility	
	Motor disabilities		

The burning of agricultural plastics is of particular concern to the Great Lakes Basin Watershed - home to 95 percent of the surface water in North America along with 21 percent of the world's surface freshwater. The Great Lakes Binational Toxics Strategy (GLBTS) classifies dioxins and furans as Tier 1 pollutants (bio accumulative toxic substances), and requires that all sources of Tier 1 pollutants are to be eliminated.

Emissions of other air pollutants associated with open burning include volatile organics (e.g. benzene), fine particulate matter (PM_{10}), polycyclic aromatic hydrocarbons(PAHs) (e.g. benzo(a)pyrene), and heavy metals.

Polyethylene (PE) is a common agricultural plastic and when burned at temperatures below 750 ˚C, as much as 41% of the mass of PE is lost and volatized prior to particle ignition. In open burning scenarios, most of the PE may have already been pyrolyzed and lost to the atmosphere as pollutants by the time the burn pile temperature becomes hot enough to produce efficient combustion.

Recycling the agricultural plastics that are used annually in Ontario would represent a net greenhouse gas savings of more than 20,000 tonnes of CO_2 equivalent, which equates to removing more than 4,000 vehicles from the road for a year.

There is a strong national need to develop a comprehensive stewardship program for waste agricultural plastics to address the lack of adequate management systems for this material, and the potential environmental impacts associated with improper disposal. Required elements of a program include the infrastructure required to collect, process, transport, and recycle materials, as well as the social marketing, incentive and regulatory supports to drive the required behavioural change.

Appendix 9 – Non-Hazardous Disposal Scenario with Variable Recovery Volumes

Table 1

Stream	Paper and Plastic Bags	Packaging	Animal Health Products	Total
Waste Volume (tonnes)	890	1,176	10	2,076
Transport Packaging Weight	-	-	1	1
Waste Volume Including Packaging	890	1,176	11	2,077
Packaging Costs	$ -	$ -	$ 3,000	$ 3,000
Disposal Transportation	$ 175,000	$ 91,000	$ -	$ 266,000
Disposal Cost	$ 102,000	$ 10,000	$ 59,000	$ 171,000
	$ 277,000	$ 211,000	$ 62,000	$ 440,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 123,000
Estimated Total	$ 318,000	$ 142,000	$ 103,000	$ 563,000

Table 2

Plastic and Paper Bags and Misc. Packaging	% Recovery				
Cost Item	**10%**	**30%**	**50%**	**80%**	**100%**
Waste Volume (Tonnes)	89	267	445	712	890
Transport Packaging Weight	-	-	-	-	-
Waste Volume Including Packaging	89	267	445	712	890
Packaging Costs	-	-	-	-	-
Disposal Transportation	$ 18,000	$ 53,000	$ 88,000	$ 140,000	$ 175,000
Disposal Cost	$ 11,000	$ 31,000	$ 51,000	$ 82,000	$ 102,000
	$ 29,000	$ 84,000	$ 139,000	$ 222,000	$ 277,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	**$ 70,000**	**$ 125,000**	**$ 180,000**	**$ 263,000**	**$ 318,000**

Appendix 9 – Non-Hazardous Disposal Scenario with Variable Recovery Volumes

Table 3

Packaging	% Recovery				
Cost Item	**10%**	**30%**	**50%**	**80%**	**100%**
Waste Volume (Tonnes)	118	353	588	941	1,176
Transport Packaging Weight	-	-	-	-	-
Waste Volume Including Packaging	118	353	588	941	1,176
Packaging Costs	-	-	-	-	-
Disposal Transportation	$ 10,000	$ 28,000	$ 46,000	$ 73,000	$ 91,000
Disposal Cost	$ 1,000	$ 3,000	$ 5,000	$ 8,000	$ 10,000
	$ 11,000	$ 31,000	$ 51,000	$ 81,000	$ 101,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	**$ 52,000**	**$ 72,000**	**$ 92,000**	**$ 122,000**	**$ 142,000**

Table 4

Animal Health Products	% Recovery				
Cost Item	**10%**	**30%**	**50%**	**80%**	**100%**
Waste Volume (Tonnes)	1	3	5	8	10
Transport Packaging Weight	1	1	1	1	1
Waste Volume Including Packaging	2	4	6	9	11
Packaging Costs	-	-	-	-	-
Transportation Cost	$ 1,000	$ 1,000	$ 2,000	$ 3,000	$ 3,000
Disposal Cost	$ 6,000	$ 18,000	$ 30,000	$ 48,000	$ 59,000
	$ 7,000	$ 19,000	$ 32,000	$ 51,000	$ 62,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	**$ 48,000**	**$ 60,000**	**$ 73,000**	**$ 92,000**	**$ 103,000**

Appendix 9 - Hazardous Disposal Scenario with Variable Recovery Volumes

Table 5

Stream	Paper and Plastic Bags	Packaging	Animal Health Products	Total
Waste Volume (tonnes)	890	1,176	10	2,076
Transport Packaging Weight	65	85	1	151
Waste Volume Including Packaging	955	1,261	11	2,227
Packaging Costs	$ 240,000	$ 317,000	$ 3,000	$ 560,000
Disposal Transportation	$ 192,000	$ 16,000	$ -	$ 208,000
Disposal Cost	$ 2,625,000	$ 6,740,000	$ 59,000	$ 9,424,000
	$ 3,057,000	$ 7,073,000	$ 62,000	$ 10,192,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 123,000
Estimated Total	$ 3,098,000	$ 7,114,000	$ 103,000	$ 10,315,000

*Please note actual figures used in the report have been rounded to the nearest $1,000

Table 6

Paper and Plastic Bags	% Recovery				
	10%	**30%**	**50%**	**80%**	**100%**
Waste Volume (tonnes)	89	267	445	712	890
Transport Packaging Weight	7	20	33	52	65
Waste Volume Including Packaging	96	287	478	764	955
Packaging Costs	$ 24,000	$ 72,000	$ 120,000	$ 192,000	$ 240,000
Disposal Transportation	$ 20,000	$ 58,000	$ 96,000	$ 154,000	$ 192,000
Disposal Cost	$ 263,000	$ 788,000	$ 1,313,000	$ 2,100,000	$ 2,625,000
	$ 307,000	$ 918,000	$ 1,529,000	$ 2,446,000	$ 3,057,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	$ 348,000	$ 959,000	$ 1,570,000	$ 2,487,000	$ 3,098,000

Table 7

Appendix 9 - Hazardous Disposal Scenario with Variable Recovery Volumes

Packaging	% Recovery				
	10%	30%	50%	80%	100%
Waste Volume (tonnes)	89	267	445	712	1,176
Transport Packaging Weight	9	26	43	69	85
Waste Volume Including Packaging	127	379	631	1,010	1,261
Packaging Costs	$ 32,000	$ 96,000	$ 159,000	$ 254,000	$ 317,000
Disposal Transportation	$ 2,000	$ 5,000	$ 8,000	$ 13,000	$ 16,000
Disposal Cost	$ 674,000	$ 2,022,000	$ 3,370,000	$ 5,392,000	$ 6,740,000
	$ 708,000	$ 2,123,000	$ 3,537,000	$ 5,659,000	$ 7,073,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	$ 749,000	$ 2,164,000	$ 3,578,000	$ 5,700,000	$ 7,114,000

Table 8

Animal Health Products	% Recovery				
	10%	30%	50%	80%	100%
Waste Volume (tonnes)	89	267	445	712	10
Transport Packaging Weight	1	1	1	1	1
Waste Volume Including Packaging	2	4	6	9	11
Packaging Costs	$ 1,000	$ 1,000	$ 2,000	$ 3,000	$ 3,000
Disposal Transportation	$ -	$ -	$ -	$ -	$ -
Disposal Cost	$ 6,000	$ 18,000	$ 30,000	$ 48,000	$ 59,000
	$ 7,000	$ 19,000	$ 32,000	$ 51,000	$ 62,000
Mature Program Overhead Costs	$ 41,000	$ 41,000	$ 41,000	$ 41,000	$ 41,000
Estimated Total	$ 48,000	$ 60,000	$ 73,000	$ 92,000	$ 103,000