

A Study of the Potential
to Increase Diversion of Vinyl
from the IC&I and Household
Waste Streams

for

The Vinyl Council of Canada

Prepared By

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Section 1: Introduction

Vinyl is the second largest volume plastic produced in the world; exceeded only by polyethylene. Vinyl applications are found in virtually every industry. The major applications for vinyl are pipe, siding, windows, wire and cable insulation, and automotive products.

Commercial manufacturing of flexible vinyl products began in the 1930's, mainly as a replacement for natural rubber. During the 1950's, it was found that vinyl could be stiffened, and rigid vinyl products began to gain popularity, particularly in the pipe industry. The introduction of vinyl building products, such as siding and windows, in the 1960's has greatly expanded the demand for vinyl resin.

Since 1970, there has been more than a 10-fold increase in the domestic production of vinyl goods. Figure 1.1 below shows the quantity of vinyl products made in Canada (domestic resin demand) and the domestic resin production. It can be noted that in recent years there has been a net import of vinyl resin to meet the demand for resin consumption.

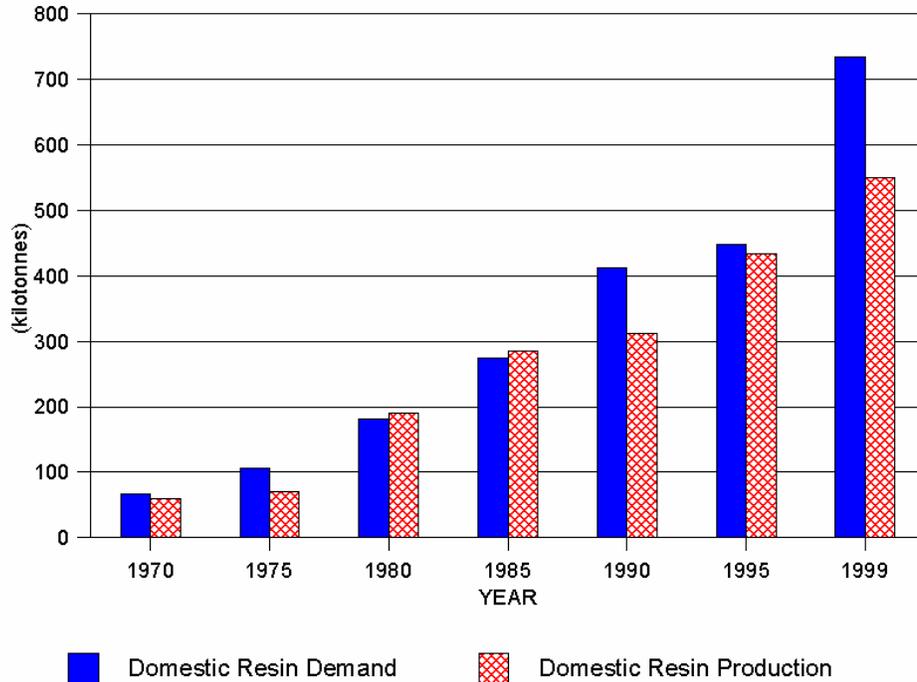


Figure 1.1: Canadian Demand and Production of Vinyl Resin

As indicated in Table 1.1, the majority of vinyl applications are durable long-life products. Therefore, currently only a small quantity of vinyl products are finding their way into the waste stream. As the vinyl products that were manufactured years ago are becoming damaged or obsolete and in need of replacement, there will be a steadily increasing quantity of vinyl waste being generated. As with most materials, the traditional method of dealing with waste vinyl has been disposal by landfilling or incineration.

Table 1.1: Canadian Vinyl Production and Applications (kilotonnes)

Vinyl Application	1970	1975	1980	1985	1990	1993	1995	1998
Pipe, Tubing, Fittings	11	33	64	87	151	139	114	175
Siding	2	5	16	39	63	102	111	140
Windows & Rigid Profiles	2	10	18	25	45	69	78	140
Insulated Wire&Cable	10	13	18	25	31	29	27	29
Automotive/Flex Sheet	8	12	20	26	30	27	32	45
Flooring	13	12	13	18	16	12	16	21
Flexible Films	8	9	10	10	17	14	12	14
Rigid Bottles, Packaging	3	3	6	9	15	15	13	15
Other	9	9	17	35	44	44	45	48

Source: ChemInfo Services Inc., *Canadian C2 + Petrochemical Report for 1995 to 1998 data*
 Various public sources for 1970 to 1980 data

The Vinyl Council of Canada and EPIC are working to promote resource conservation and the recycling of vinyl.

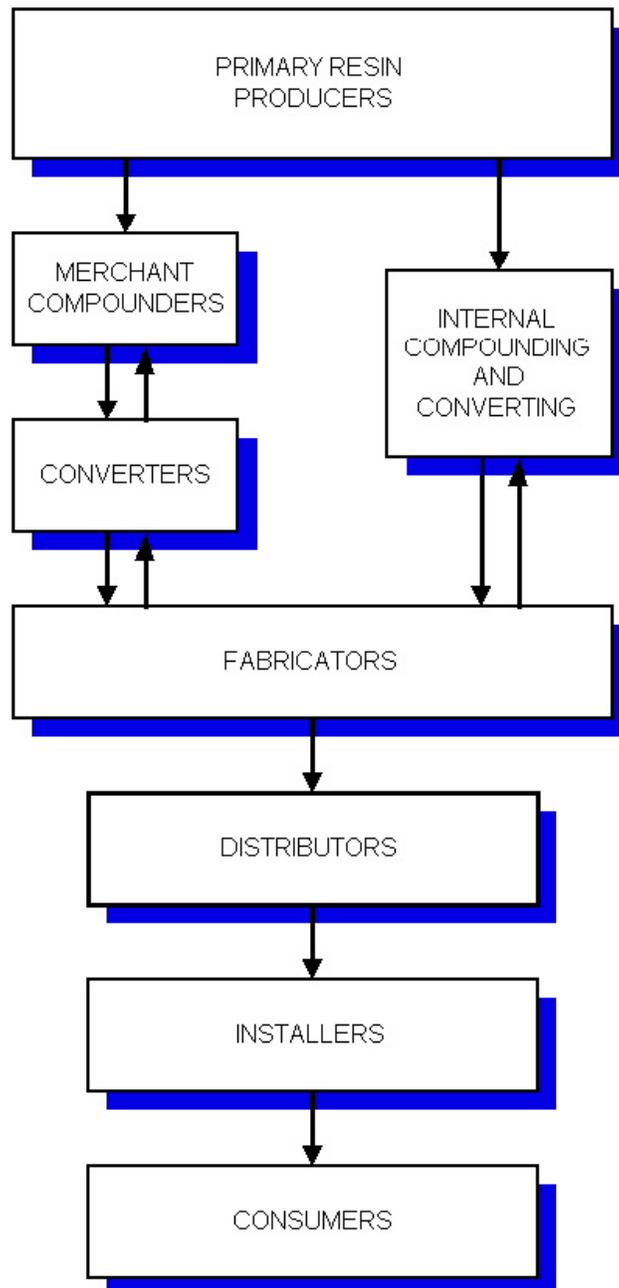
The purpose of this study is to:

- provide information regarding the quantity and properties of the vinyl waste stream;
- determine the current vinyl recycling rate;
- outline the impediments to vinyl recycling; and,
- present plans that will assist in maximising the recyclability of vinyl waste and products.

This report focuses on all vinyl waste generated in Ontario, with the exception of medical wastes, vinyl coated fabrics, household film wraps, and processing scrap handled by the original manufacturer. Any processing scrap that undergoes a change of title (e.g. sent for regrinding and then sold to a broker) is included in the production scrap quantities.

In addition to the vinyl product that has reached the end of its useful lifecycle, vinyl waste is also generated throughout the manufacturing process. There are

two primary producers of vinyl resin in Ontario. Royal Vinyl has a plant in Sarnia and Oxyvinyl has a facility in Niagara Falls, Ontario. Another Oxyvinyl facility is located in Fort Saskatchewan, Alberta. There are numerous secondary producers that *compound* and *convert* the vinyl resin into a variety of products. Oftentimes a *fabricator* is also involved in the manufacturing process, such as a window manufacturer that produces the actual window from the window profiles obtained from a *converter*. In the case of some products, such as pipe, siding, wire and cable, and flooring, waste products are also generated during the installation phase when the material is cut to the required size. This report considers vinyl waste that is generated by the manufacturing industry, the construction industry, and by the final consumers of the products.



For the sake of this report, the waste stream is defined as follows.

Post-Consumer Waste is any material that has entered the stream of commerce, served its intended purpose, and is then considered to have completed its useful lifecycle. This material may be placed in the waste stream either by the consumer that used the product, or a contractor that has been hired to remove it (i.e., siding, pool liners).

Post-Industrial Waste has not been used for its intended purpose. It is waste that is created either as:

- *production scrap*, which is any processing line scrap or defective products generated during the manufacturing process and which changes title; or,
- *installation waste*, which includes the offcuts and other wastes generated during the construction or installation phase.

Whereas post-industrial scrap is considered to be a waste almost immediately after it is produced, the point at which a product is declared a post-consumer waste is dependent upon its life expectancy. Due to the long life expectancy of vinyl products, the vinyl waste generated in a given year differs significantly from the quantity of vinyl produced.

In the process of completing this study, in-depth interviews were conducted with numerous vinyl producers, manufacturers, fabricators, and recyclers. Because much of the information that was discussed in these interviews is of a proprietary nature, many of the companies were hesitant to have information concerning their waste generation in the public domain. Therefore, to protect the interests of all companies interviewed, the information in this report is supplied in the aggregate. No names or actual figures applying to any individual company will be revealed, with the exception of the listing of vinyl recyclers in Section 5.

Section 2: The Vinyl Waste Stream

In 1998, there was 534 kilotonnes of vinyl resin produced in Canada. There was also a net import of another 304 kilotonnes, an export of 210 kilotonnes of resin, and a decrease in the resin inventory of 2 kilotonnes, for a total Canadian secondary vinyl production of 627 kilotonnes.

As indicated in Table 2.1, almost all of the resin produced in 1998 was used to manufacture products that are expected to stay in service for a period of 10 years or more, sometimes in excess of 50 years.

Table 2.1: Vinyl Products Manufactured in Canada in 1998 (kilotonnes)

APPLICATION	(K-tonnes)	PERCENT
Water and Sewer Pipe	175	28%
Siding	140	22%
Windows	140	22%
Wire & Cable	29	5%
Automotive Products	45	7%
Flexible Plastic Sheet (pool liners)	14	2%
Flooring	21	3%
Rigid Packaging and Bottles	15	2%
Other (hoses, credit cards, toys)	48	8%
Total Domestic Production	627	

This section of the report determines the projected quantity of vinyl waste that will be generated in Ontario over the next ten years. As outlined in Section 1, the vinyl waste stream for each application consists of:

- production scrap;
- installation scrap; and,
- post-consumer waste.

The amount of vinyl *production scrap* was determined based on the Ontario production quantities and typical scrap rates for each application. First of all, the projected Canadian production for each of the 9 vinyl applications was determined based on the growth rate experienced over the past 10 years. Ontario production was then estimated based on a general percentage of the

Canadian production that is manufactured in Ontario. For example, a high percentage of the vinyl siding produced in Canada is manufactured in Ontario, however most of the vinyl flooring manufacturers are located in Quebec, therefore only a small percentage of Canadian vinyl flooring is being made in Ontario. The typical scrap rates that result from the manufacturing of each product were established based on discussions with the specific manufacturers (Section 4 contains more detailed information on waste generation for each of the applications). As defined in Section 1, the production scrap rate includes only scrap that undergoes a change of title. Internally tolled material, or material tolled under contract where there is no change of title, is not included as production scrap.

Installation scrap is based on the amount of product that was used in Ontario. The projected Canadian production figures were adjusted to reflect net imports or exports of the product, as determined from *Industry Canada Trade Data* and the report, *A Technical and Socio-Economic Comparison of Options to Products Derived from the Chlor-alkali Industry (Cheminfo Services Inc, November 1997)*. The adjusted Canadian vinyl usage was then multiplied by 38% to calculate the Ontario usage. Typical installation scrap rates were determined based on discussions with installers and contractors.

In order to determine the quantity of *post-consumer waste* that will be generated over the next ten years, it is necessary to determine how long each of the product applications are expected to remain in useful service. This was done through discussions with manufacturers and trade associations. The expected quantity of post-consumer waste is based on a consideration of the quantity used in the past in Ontario that is now thought to be approaching the end of useful life.

Tables A.1 – A.8 in Appendix A, show the calculations that were used to establish the projected vinyl waste quantities. These quantities include only the vinyl component of the waste, and do not take into account additives, fillers or other materials that may be incorporated in the vinyl waste.

2.1 Pipe

Vinyl water and sewer pipe was introduced in Canada in the 1960's and has been increasing in market share of the pipe industry ever since then. Although vinyl pipe accounts for over 80% of small diameter (4"-12") pipe currently being installed, it makes up only about 10%-20% of the water and sewer pipe inventory currently in-place, due to the large quantities of old concrete, cast iron, and ductile iron pipe still in service (*Source: CHEMinfo Services*).

Post-consumer Waste:

Vinyl pipe is basically inert, and should theoretically last for hundreds of years without deterioration. In practice, however, plastic pipe is expected to have a lifespan of about 50 to 100 years, either for capacity reasons or due to damage or interaction with fittings (*Source: Uni-Bell PVC Pipe Association*). When water and sewer pipe is replaced, the old pipe is often left in the ground. It is therefore not expected that any significant amount of post-consumer vinyl pipe wastes will be generated until after the middle of the 21st century.

Production Scrap:

There is a production scrap rate of approximately 1% from the production of vinyl pipe.

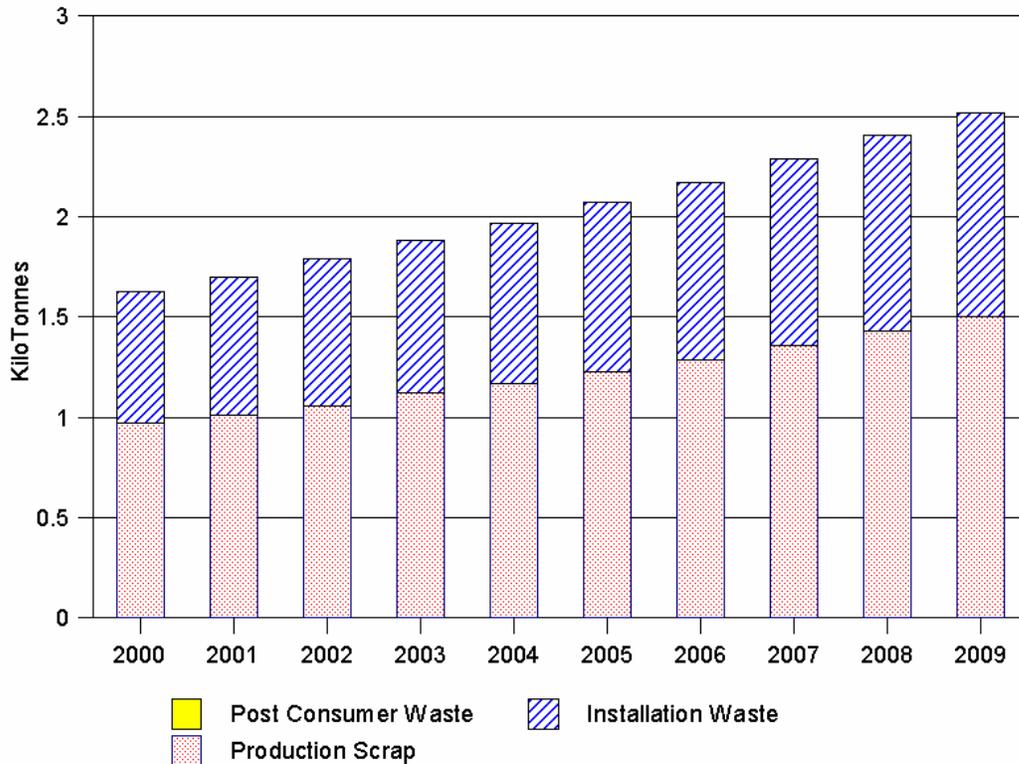
Installation Waste:

Most construction companies attempt to stockpile short pieces of vinyl pipe that result from cutting the pipe to the proper length during installation. If possible these off-cuts are used in other areas of the project, or carried over to other projects. There is typically only about a 1% scrap rate when vinyl pipe is being installed. This material is typically not recycled.

Total Waste:

As shown in Figure 2.1, the generation of waste vinyl pipe in Ontario is expected to increase slightly over the next ten years. The pipe waste will be composed of production scrap and installation scrap.

Figure 2.1: Expected Generation of Vinyl Pipe Waste in Ontario



2.2 Siding

Vinyl siding was first introduced in the 1960's and by the mid-1980's had surpassed aluminium to become the most popular siding material. The aluminium siding market is virtually non-existent today, having been replaced by vinyl products.

Shutters, soffits, fascia and eaves troughs are also included in this category, and make up about 10% of the quantity of vinyl siding.

Post-Consumer Waste:

According to the Canada Mortgage and Housing Corporation, vinyl siding has an expected lifespan of approximately 30 years. Therefore, siding that was produced prior to 1980 is expected to become waste material during the next 10 years. As indicated in Table 1.1, a total of 2 kilotonnes of vinyl siding was produced in Canada in 1970. It is therefore expected that the amount of vinyl siding that will be scrapped in the year 2000 will be small, but that post-consumer siding waste will increase significantly by the year 2009.

Production Scrap:

The quantity of production scrap from the manufacturing of vinyl siding is very low, typically 1% or less of the manufactured quantities.

Installation Waste:

The installation of vinyl siding generates very little scrap, most of which occurs from angular cuts for gable ends, offcuts from corner strips, or leftover material. Contractors estimate that the scrap rate during installation of vinyl siding is between 2 – 5%. This material is typically not recycled.

Total Waste:

The total vinyl siding wastes expected to be generated in Ontario during the next 10 years is indicated in Figure 2.2. As indicated, the waste initially consists mainly of production scrap and installation waste, with the quantity of post-consumer waste entering the waste stream increasing in the later years.

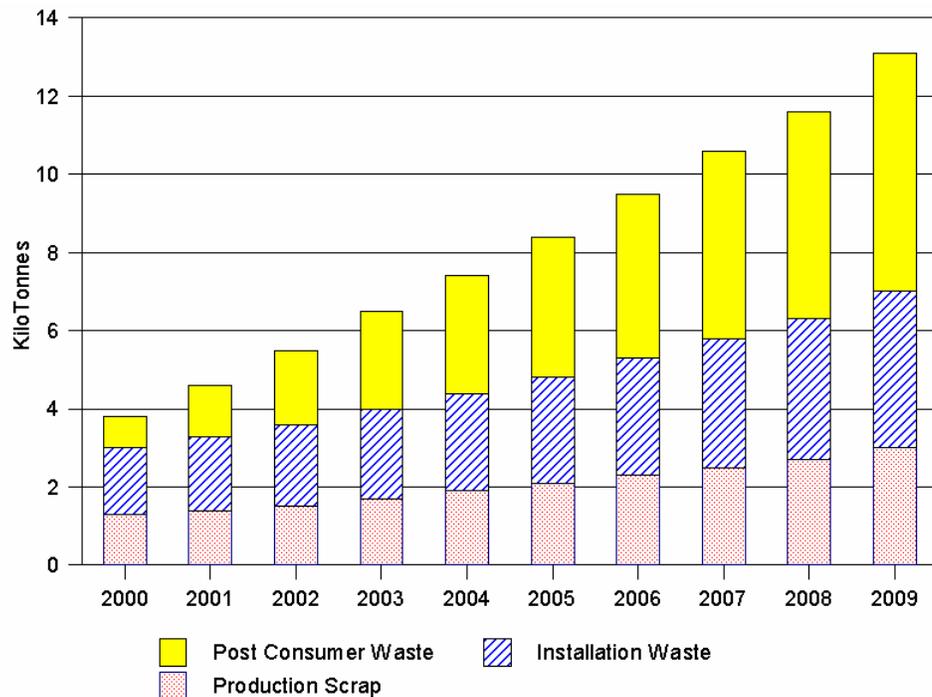


Figure 2.2: Expected Generation of Vinyl Siding Waste in Ontario

2.3 Windows

Vinyl windows were first introduced in Canada in the 1970's, but were initially slow to gain a substantial market. The popularity of vinyl windows increased significantly during the 1990's however, and they are now the most commonly installed windows.

Post-Consumer Waste:

According to the Canada Mortgage and Housing Corporation, vinyl windows have an expected lifespan of 20 years, therefore windows that were installed between 1980 and 1989, will likely be replaced within the next ten years.

Production Scrap:

Production scrap is generated at two steps in the manufacturing process for windows. Although there is virtually no production scrap from the manufacturing of window profiles, there is a scrap rate of about 2% in the window fabrication process.

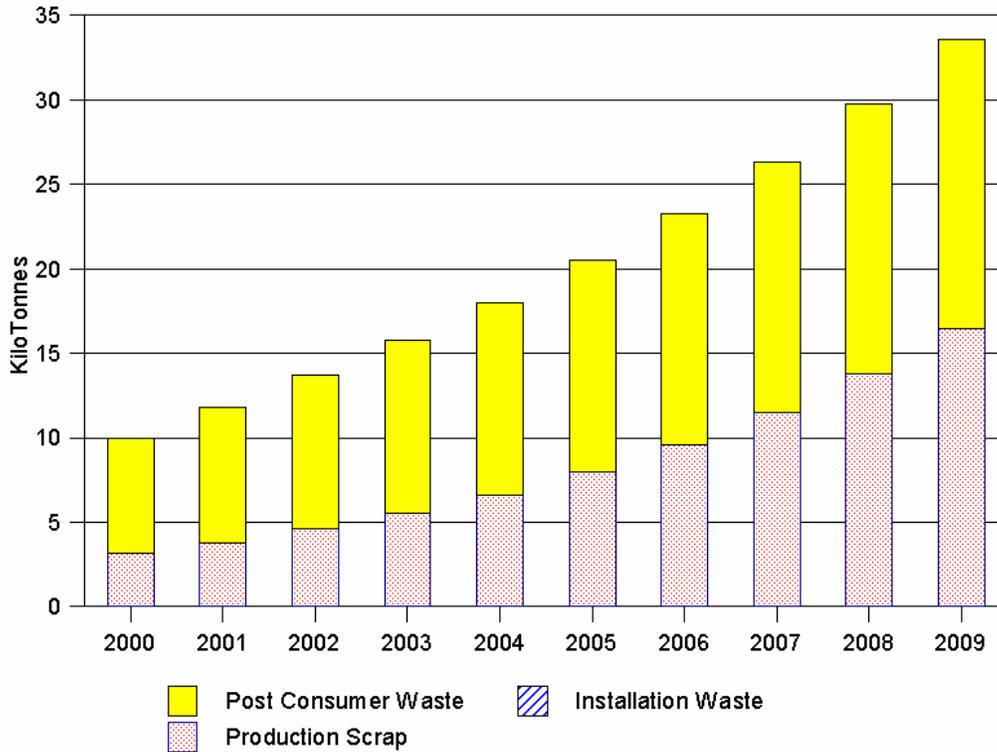
Installation Waste:

Because windows are typically installed as complete units there is no significant waste quantity generated during the installation process.

Total Waste:

As shown in Figure 2.3, the amount of vinyl window waste generated in Ontario during the next 10 years is expected to increase steadily, mostly as a result of the steady increase in vinyl window production.

Figure 2.3: Expected Generation of Vinyl Window Waste in Ontario



2.4 Wire and Cable

Vinyl has been used for wire and cable insulation and jacketing since World War II, when vinyl replaced rubber electrical insulation on board ships because of its flame retardance.

Post-Consumer Waste:

The lifespan for wire and cable applications varies greatly. Building wiring can remain in place for many years, although applications such as power cords for electronic equipment have a relatively short period of use. It has been assumed that wire and cable applications last an average of 20 years before replacement, therefore insulated wire and cable installed between 1980 and 1989 will likely be replaced within the next ten years.

Production Scrap:

Interviews with wire and cable manufacturers determined that a vinyl scrap rate of 4% is typical for the production of insulated wire and cable.

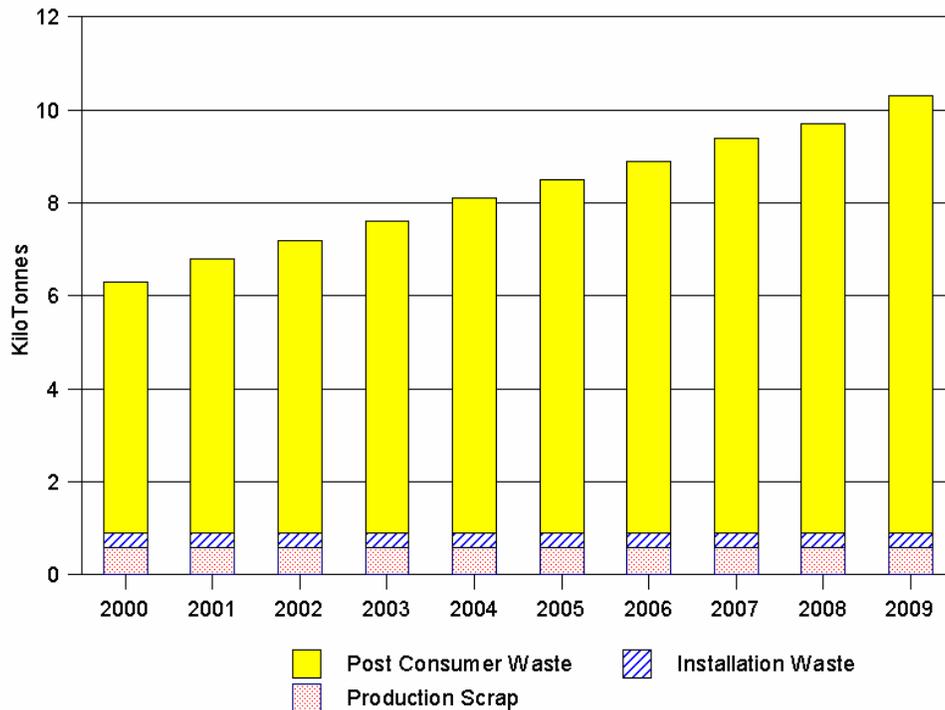
Installation Waste:

There is generally more waste generated in the wiring of a residential building than with a large industrial project. Up to 5% of the wire used for a residential job may go to waste as a result of cuttings and spool ends. The wire and cable for an industrial job however is higher cost and is often ordered to length so that there is very little waste of material. Overall, approximately 3% of insulated wire and cable is scrapped during the installation process.

Total Waste:

The total vinyl wire and cable waste expected to be generated in Ontario during the next 10 years is indicated in Figure 2.4. As indicated, most of this waste is post-consumer material.

Figure 2.4: Expected Generation of Vinyl Insulated Wire&Cable Waste in Ontario



2.5 Flexible Plastic Sheet Products

Flexible vinyl sheet is used in many applications, however the two main uses are for vehicle trim (dashboard panels, upholstery, floor mats) and pool liners.

Post-Consumer Waste:

Flexible vinyl sheet applications have a typical lifespan of 10 years before replacement; therefore flexible sheet products that were put in service between 1990 and 1999 will likely be replaced within the next ten years.

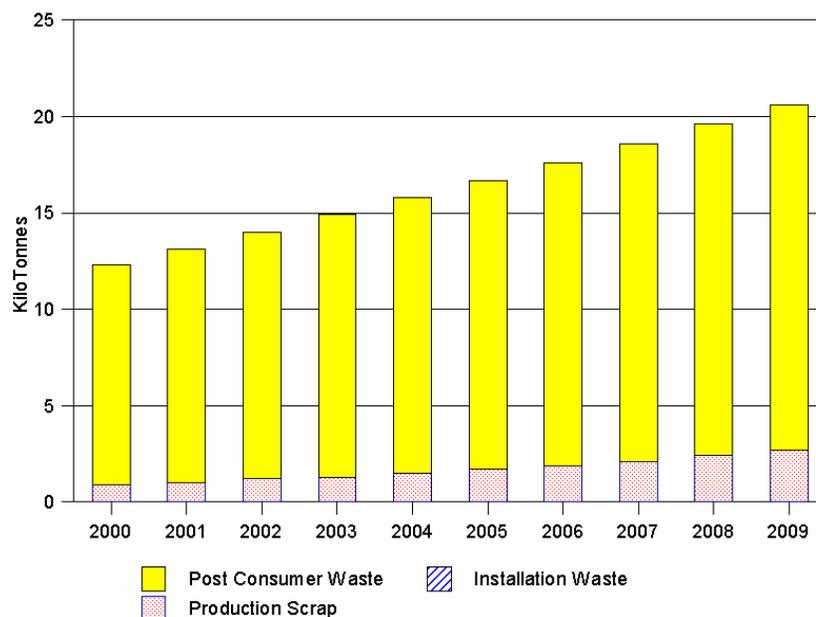
Production Scrap:

The production scrap rate for flexible plastic sheet products range from a low of 1% for the manufacturing of pool liners to 3% for the production of vehicle trim. An average of 2% production scrap has been assumed for the production of flexible plastic sheet products.

Total Waste:

As indicated in Figure 2.5, most of the flexible vinyl sheet waste that will be generated in Ontario during the next 10 years is post-consumer material.

Figure 2.5: Expected Generation of Flexible Vinyl Sheet Waste in Ontario



2.6 Flooring

Vinyl flooring appeared on the Canadian marketplace in the 1960's as a replacement for linoleum for residential and commercial applications. Sheet vinyl flooring and vinyl tiles contain a high percentage of filler and additives.

Post-Consumer Waste:

Vinyl flooring has a typical lifespan of 10 years before replacement, therefore vinyl flooring that was installed between 1990 and 1999 will likely be replaced within the next ten years.

Production Scrap:

There is very little vinyl flooring produced in Ontario. A production scrap rate of 3% has been assumed for the production of vinyl flooring.

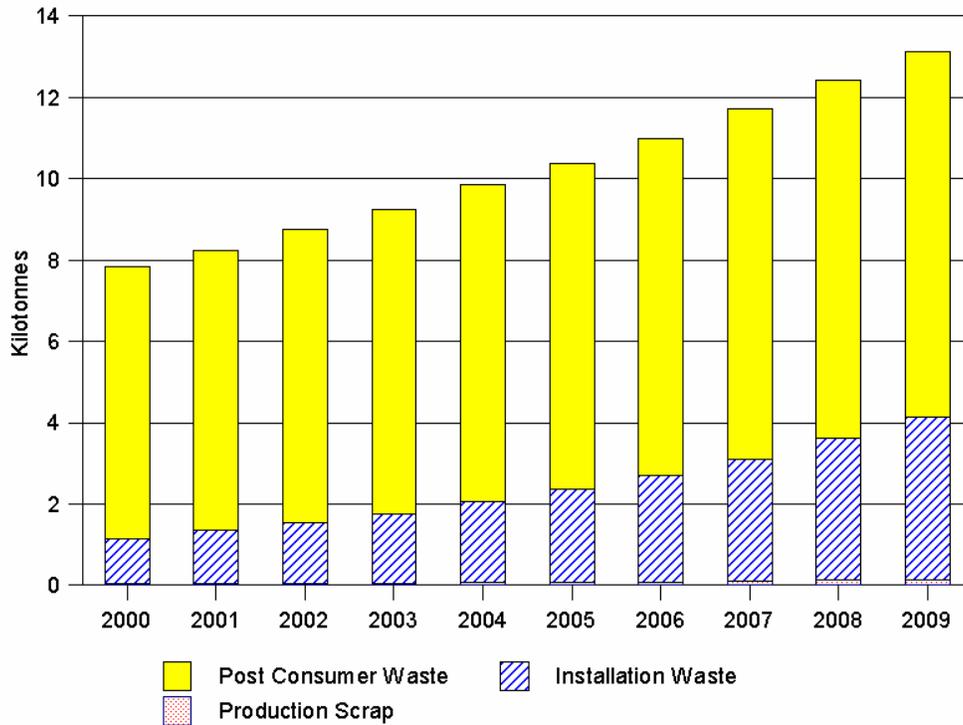
Installation Waste:

Vinyl sheet flooring is typically manufactured in 12' widths. For installations in rooms wider than 12', the flooring must be seamed, although it is desirable to have the least number of seams possible with sheet flooring. Bathrooms are another popular area for vinyl sheet flooring and typically generate a high percentage of scrap material. Flooring contractors estimate that on average 10% of the material is wasted during installation of vinyl sheet flooring.

Total Waste:

The total vinyl flooring waste expected to be generated in Ontario during the next 10 years is indicated in Figure 2.6. The majority of the waste is post-consumer material, along with some installation waste. Due to the small amount of vinyl flooring that is manufactured in Ontario, the production scrap is insignificant.

Figure 2.6: Expected Generation of Vinyl Flooring Waste in Ontario



2.7 Packaging

Vinyl has a very small share of the plastic packaging industry, and is used mainly in “blister-pak” thermoformed packaging applications. Some products are packaged in rigid vinyl bottles, however the use of rigid vinyl packaging is decreasing. Overall, only 2% of the vinyl products made in Canada are packaging applications.

Post-Consumer Waste:

The main difference with this application from other vinyl products, is that plastic packaging is a short-term use, with the products becoming a waste almost immediately (within a year) after they are manufactured.

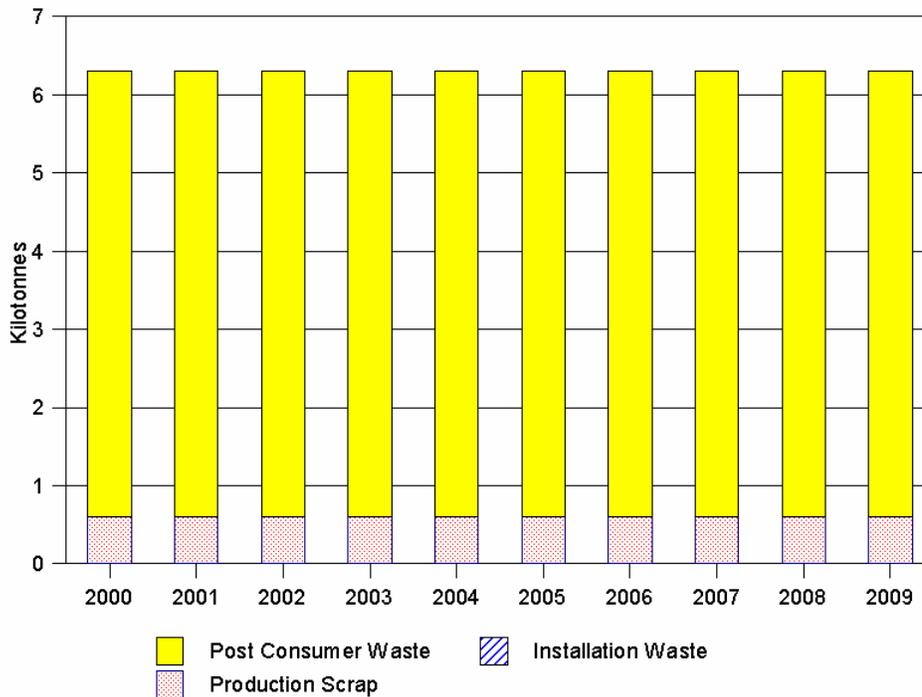
Production Scrap:

The manufacturing of blister-pak, the major type of vinyl packaging, has a relatively high 8% production scrap rate.

Total Waste:

The amount of vinyl packaging waste in Ontario is expected to remain relatively constant over the next ten years, at approximately 6 kilotonnes tonnes of material a year, which is essentially all post-consumer material.

Figure 2.7: Expected Generation of Packaging Waste in Ontario



2.8 Other Uses

There are a number of miscellaneous products such as credit cards, hoses, blinds, shower curtains, toys, and other household items that are produced from either flexible or rigid vinyl materials. Because this category includes such a wide variety of products, it is impossible to establish the net import/export information for these miscellaneous vinyl products. Although the quantities presented in this section do not include any imported quantities, it is expected that the amount of miscellaneous vinyl products that are imported into Canada is quite high.

Post-Consumer Waste:

Most of these miscellaneous applications have an expected lifespan of approximately 10 years, therefore the products that were manufactured between 1990 and 1999, will likely be replaced within the next ten years.

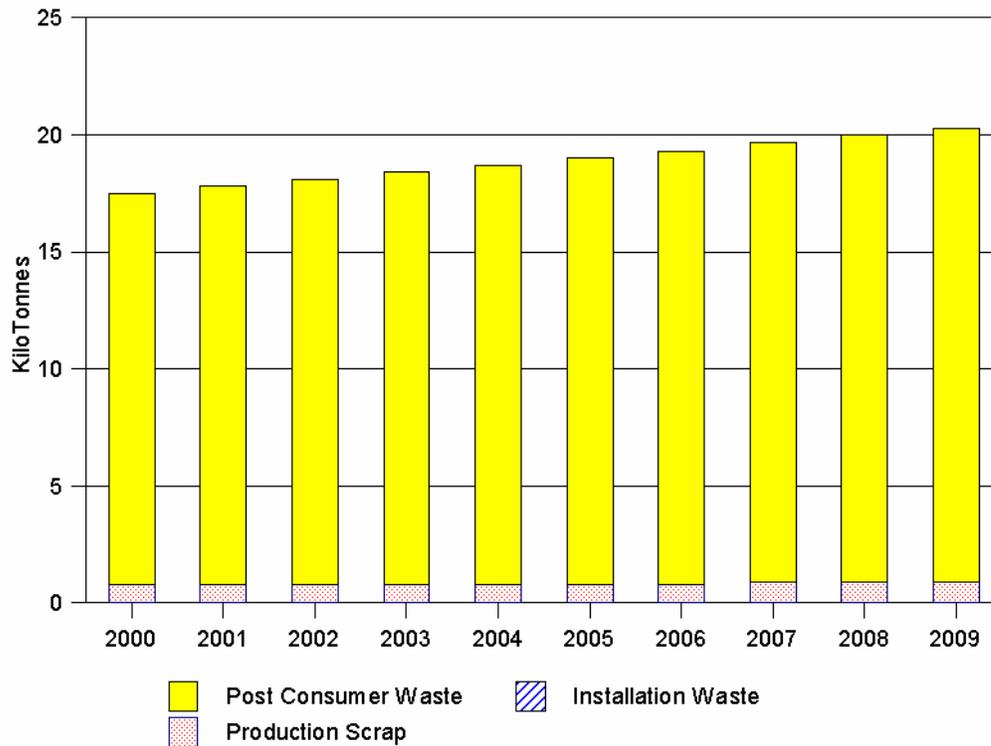
Production Scrap:

A production scrap rate of 3% has been assumed for the production of miscellaneous vinyl products.

Total Waste:

The total vinyl miscellaneous products waste that will be generated in Ontario during the next 10 years is expected to increase slightly. Almost all of this material is post-consumer waste.

Figure 2.8: Expected Generation of Other Waste in Ontario



2.9 Summary

Because vinyl is typically used in the manufacturing of durable goods, the waste stream to date has not been composed of a high proportion of post consumer vinyl products. In the past, most vinyl waste was generated either from the manufacturing or installation processes. This is changing however, as durable vinyl goods that were manufactured years ago are starting to end up in the waste

stream. In particular, windows, wire and cable, automotive products, pool liners, flooring, packaging and miscellaneous items are being disposed of in increasing quantities. Vinyl siding is just starting to enter the post-consumer waste stream. Although pipe is a major application for vinyl resin, it is not anticipated that vinyl pipe will enter the waste stream in any significant quantities in the next decade.

The estimated vinyl waste stream for the year 2000 is 52,500 tonnes of post-consumer vinyl waste and 16,000 tonnes of post-industrial waste. Figure 2.9 indicates the composition of this waste. The projected vinyl waste stream over the next 10 years is outlined in Table 2.2.

Figure 2.9: Expected Vinyl Waste Quantities in Ontario for the Year 2000

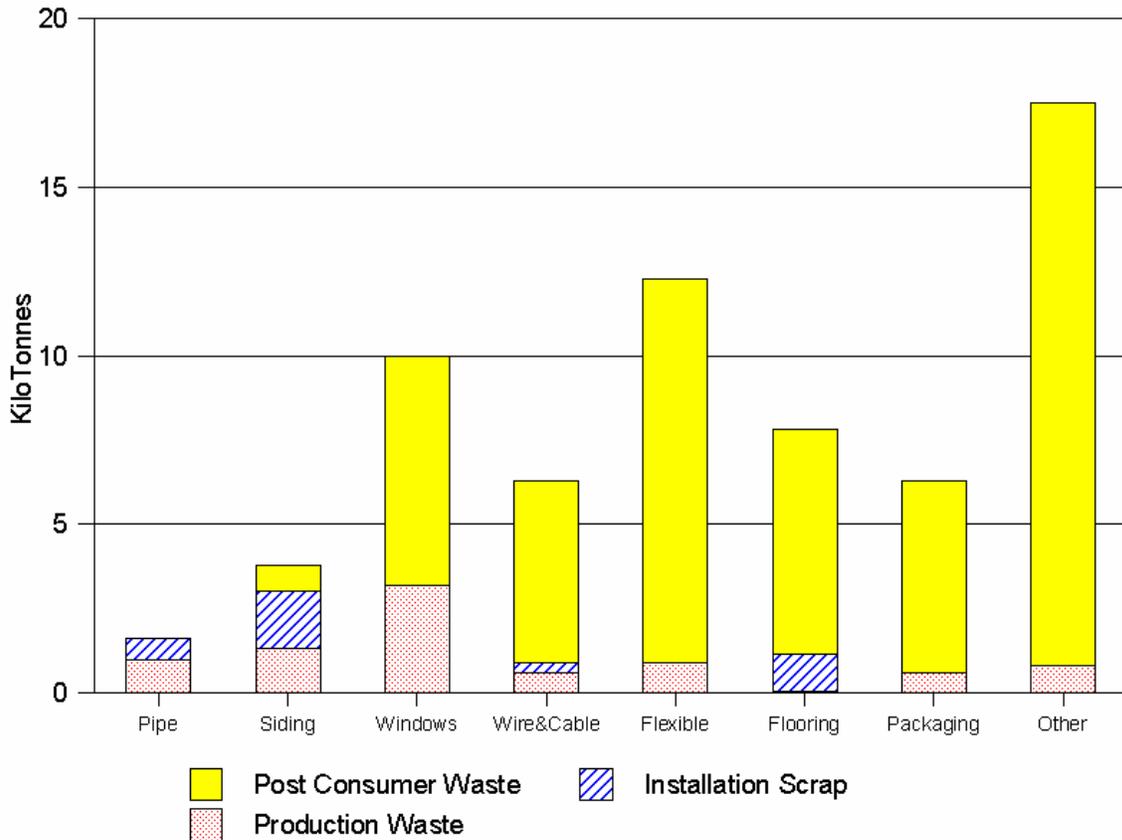


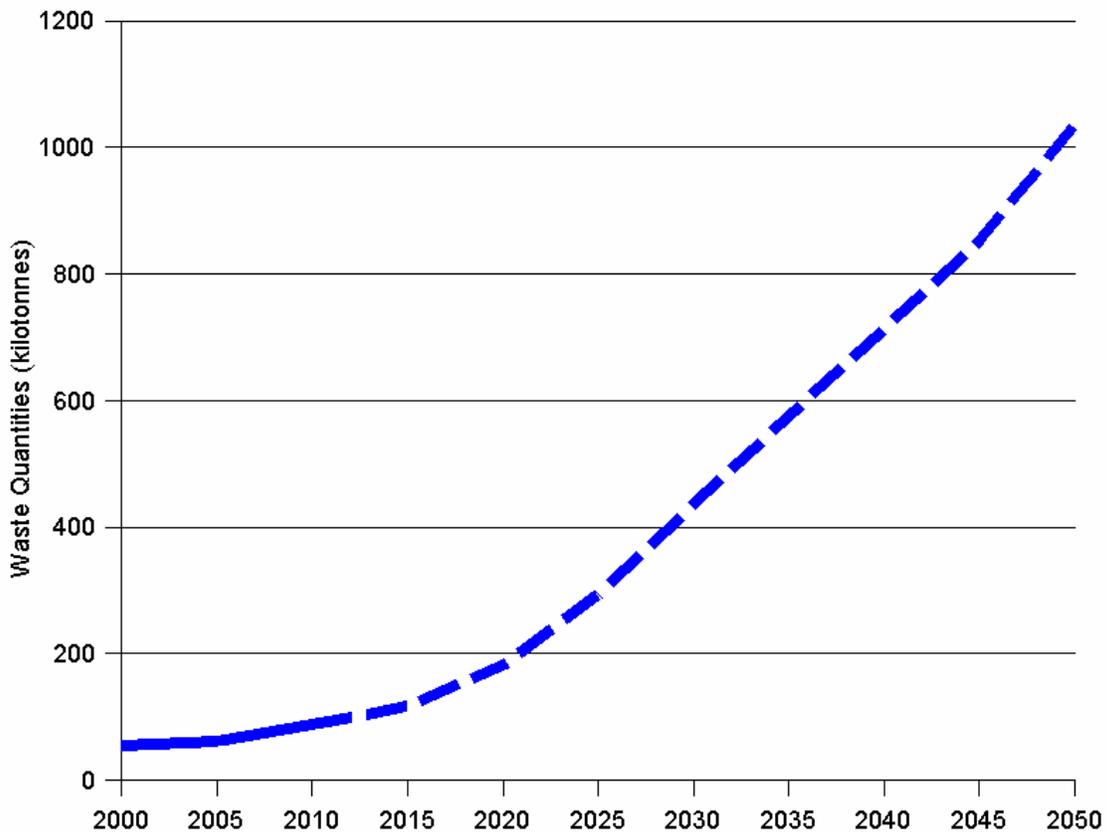
Table 2.2: Summary Table

2.10 Looking To the Future

The next 50 years will see a tremendous increase in the quantities of vinyl post-consumer wastes that will be generated as a result of vinyl products that were manufactured many years ago finally reaching the end of their long lifespan. The vinyl industry needs to prepare for this increase in vinyl waste, and plan to recover and recycle as much of this material as possible.

Figure 2.10 shows the quantity of post-consumer vinyl waste that is projected to enter the waste stream over the next 50 years, based on the quantities of vinyl products currently in use and anticipated future vinyl production. Table B.1 in Appendix B outlines the projected post-consumer waste quantities for each product application.

Figure 2.10: Post-Consumer Vinyl Waste Projections (2000-2050)



Section 3: Properties of Vinyl Waste

The ability to recycle vinyl waste and the economics of the recycling process are dependent upon the physical and chemical properties of the material and the degree of contamination of the waste. Contamination results from mixing different types of vinyl products, as well as from non-vinyl materials, such as metal, glass and other plastics that are attached to the vinyl waste.

The considerations that determine the property of a vinyl waste, and therefore its recyclability, are:

- whether the material is rigid or flexible;
- the types of additives;
- the types of vinyl compounds;
- the production date;
- post-consumer or post-industrial materials; and,
- type and degree of contamination

Rigid or Flexible

Vinyl is typically classified as to whether it is rigid or flexible. Rigid vinyl applications have a lower additive content, while flexible vinyls may contain more than 50% additives to give them their soft and flexible characteristics. It is generally preferred to keep rigid and flexible vinyl waste separate from each other and to recycle them into a similar application, if possible. Although a rigid vinyl can be recycled into a flexible vinyl product by incorporating more additives, a flexible vinyl cannot be recycled into a rigid product without being reformulated.

Types of Additives

One of the aspects that makes vinyl so challenging to recycle is that there is such a wide range of vinyl compounds that can be found in vinyl waste products. There are many different additives that are used in the manufacturing of vinyl products in order to achieve the specific physical appearance or properties necessary for the end product use. It is important to know the composition of any waste vinyl materials that may be recycled into new vinyl products. Typically pigments or colorants are added to the resin during the compounding process, as well as lubricants which help to reduce the friction during processing. Depending on the end use of the product, flame retardants, heat stabilizers, antioxidants, or UV stabilizers may be added. Blowing agents are used to produce lightweight

structural foam products. Often fillers or extenders are used to enhance mechanical properties and to reduce the cost of raw materials.

The Types of Compounds

Although there are very few primary producers of vinyl resin, there are numerous compounders that convert the resin into vinyl pellets and products. These compounders incorporate stabilizers, filler, and a number of other additives to the basic vinyl resin. Because each secondary producer uses a proprietary process, the actual composition of vinyl products may differ, even in the same application.

The Production Date

The compounds and additives used in vinyl products have changed over time, as new materials and technological advances come on stream. Therefore, the properties of window profiles may differ drastically in windows produced today, from windows that were produced 20 years ago. Since most vinyl applications are such long-lasting products, it is important to be aware of the formulations that were used years ago when recycling post-consumer waste products.

The age of the product may also affect its properties as a result of discolouration, weathering, cracking, or other age-related degradation of the material.

Post-Consumer or Post-Industrial

Post-consumer wastes generally have more contamination from dirt and other materials (e.g. nails, glass, wire, other plastics) than post-industrial vinyl wastes. There may be additional contamination of the vinyl if it is collected with other materials.

The properties outlined above determine the degree of difficulty in recycling vinyl products. Wherever possible, it is best to try to recycle products into an application similar to the initial product so that the amount of reformulating is reduced. Due to the diverse nature of vinyl products, it is often necessary to use the recycled material in a lower-grade application, where colour, additives and contamination are not as critical.

Table 3.1 outlines the typical characteristics and level of contamination of the various vinyl applications that are part of this study. This information is important in determining the challenges in recycling vinyl products. It is obvious that vinyl waste materials with the least amount of additives and contamination are the easiest to recycle.

Table 3.1: Characteristics of Vinyl Wastes

PRODUCT	POST-INDUSTRIAL	ADDITIONAL POST-CONSUMER CONTAMINATION
Water and Sewer Pipe	Contains stabilizers	soil, dirt, fittings, adhesives
Siding	Contains UV stabilizers, impact modifiers, fillers, and pigment	nails, paint, sealants, caulking
Windows	Contains UV stabilizers, impact modifiers, and filler. Some older products may contain heavy metals	glass, caulking, metal fittings, paint
Wire & Cable	Contains approx. 50% additives, including plasticizers, fillers, and lead stabilizers.	copper wire, other metals, fibre optics, plastic connectors
Flexible Plastic Sheet (pool liners, vehicle trim)	Contains approx. 50% plasticizers, fillers, and stabilizers Vehicle panels are laminated vinyl and polyurethane foam	adhesives, metal strips and fittings
Flooring	Contains over 50% fillers and additives	adhesives, dirt
Rigid Plastic Packaging and Bottles	May contain pigment	foil or fibre backing, staples
Other (hoses, credit cards, toys, curtains)	Hose is reinforced with fibre, Magnetic strips on credit cards	metal fittings

Section 4: Current Vinyl Recovery

The recycling and general waste generation practices of the major vinyl fabricators and processors in Ontario were examined to determine the current vinyl recovery. A total of 82 companies were interviewed in order to establish a baseline of production, scrap rates and recycling rates for the industry.

This survey was facilitated by the requirement in Ontario for larger companies to complete a *Waste Audit* and to formulate a *Waste Reduction Workplan* to comply with Regulation 102/94 of the *Environmental Protection Act*. The requirement to conduct a Waste Audit is also the cornerstone to the implementation of an Environmental Management Program, which is an integral part of the requirements for ISO 14000 certification. In the process of conducting a Waste Audit, a company must address the quantity and sources of all waste generation. As such, there is information available on the amount of vinyl being landfilled as well as reused and recycled.

Wherever possible, the company's Waste Audit was used to obtain the information for this report.

The information gathered indicates that most of the production scrap generated in the manufacturing of vinyl products is reused or recycled. This is mainly because the scrap material is less contaminated and more homogeneous.

The following waste materials are typically generated from the manufacturing of vinyl products:

- purgings and drools;
- ribbon, flake, filings and dust;
- quality control failures; or,
- screws and runners

In the injection and extrusion equipment commonly used for moulding vinyl materials, the vinyl resin is in a molten state. The vinyl is removed or *purged* from the equipment in the event of a shutdown, colour change, or changing to a non-vinyl material. The purging compound is typically landfilled if a material other than vinyl is used as the purging agent. The resulting blends or cross contamination of materials cannot be reprocessed because of the incompatibility of the two resins being used. At present there is no known technology that can economically separate this purging compound.

A *drool* is similar in appearance to a purge, however a drool occurs when there is a need for a die or colour change only. The resulting *drool paddy* is pure vinyl and can be reprocessed back into a recoverable vinyl product. This material can be recycled in-house or off-site if it is identified and separated from similar appearing non-vinyl purging compounds. Occasionally drools are produced that are so large that the centre core of heated material causes a breakdown of the physical properties of the vinyl. This can result in rendering the material unusable unless the material is reground and restablized by a compounder. If possible, drool size should be limited to 25 pounds or less.

Ribbon, flake, filings or dust are the products of finishing processes such as bevelling, creating gasket grooves and polishing. This material is too light to be reintroduced to the reuse process however there are emerging technologies whereby the material is densified so as to permit the proper flow characteristics required for reuse.

Quality control failures usually consist of vinyl materials or products that have failed physical property specifications i.e. hardness, cold or hot temperature properties, which could lead to failure in the field. Material that fails simply because of physical shape as in a “short shot” is usually reground and reused.

Screws and runners are generally produced during the injection moulding process near the point where the molten vinyl enters the mould.

It was found that some large processors of vinyl material send their production scrap off-site for tolling. Tolling is defined as size reduction or grinding of scrap off-site on a cost per pound basis where no change of ownership is involved and the material is returned to the generator for reuse. It is typical for the tolling company to be dedicated to handling the production scrap from one individual company in a specialised relationship where there is no change of title of the material. These tolling quantities are therefore not included in the recovery rates outlined in this study.

It was determined however, from the facilities observed, that some regrind which fails specification enters the recycling market through the various networks of traders, processors and brokers. The amount can vary widely but it is estimated to be about 10% of the material tolled ends up in the recycling market.

The recycling of post-consumer waste, though emerging, is still relatively new due to the lack of an adequate supply of vinyl products to permit the economies of scale necessary to make it feasible.

This section outlines the amount of recycling of vinyl scrap by industry sector. In-house regrinding or tolling of scrap is not included, so as to focus on the development of markets and separation technologies that are emerging to reduce the amount of vinyl material going to landfill. This section also reports on

new emerging technologies as well as technologies already in place in the Ontario marketplace and environs

4.1 Pipe

As shown in Figure 2.1 on page 7, there is virtually no post-consumer vinyl pipe waste currently being generated, and very little installation scrap generated. The installation scrap that is generated is typically not recycled.

Almost all of the production scrap generated from pipe production is reground near the point of generation or is sent out for tolling. There is very little vinyl pipe in the waste stream going to landfill. All companies interviewed have stringent environmental policy statements that discourage the disposal of vinyl waste products.

According to the waste audit data reviewed, vinyl makes up 40% - 60% of total waste going to landfill from pipe manufacturers. This consists of non-recyclable purge material and contaminated pieces. All of the vinyl pipe manufacturers that were interviewed have good recycling programs for the more common recyclable materials such as paper, cardboard, bottles, and cans. No facility had a waste diversion rate less than 60% of all waste generated, and some plants had waste diversion rates exceeding 80%.

Although pipe production generates an overall scrap rate of approximately 5% (including toll material), it is estimated that only 320 – 480 metric tonnes of this scrap goes to landfill, and the remainder is recycled internally or by scrap processors. This figure confirms the findings of the counterpart US report, *Post-Industrial and Post-Consumer Vinyl Reclaim – Material Flow and Uses in North America* (Principia Partners, December 1998).

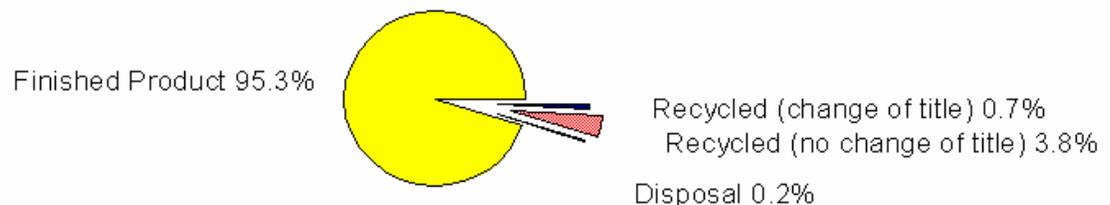


Figure 4.1: Production Scrap From the Manufacturing of Vinyl Pipe

4.2 Siding

Interviews were conducted with major vinyl siding producers to determine the amount of production scrap that is generated in the manufacturing of vinyl siding. There is approximately 1% production scrap that undergoes a change of title, however virtually all (99%) of this material is recycled.

Installation scrap, which is the material left over from cuttings and end pieces when vinyl siding is installed, accounted for between 2% and 5% of the total. Interviews with installers indicated that virtually all of this material is landfilled, as there is no infrastructure available to conveniently collect the vinyl scrap for recycling.

Many installers indicated that they would recycle vinyl if there were convenient locations to collect the material. Most installers indicated that a convenient location would be at a transfer station or landfill site. Currently installers treat vinyl like any other waste at the construction site and dump it with other rubbish, thus making its recyclability more challenging.

As was previously discussed, the amount of vinyl siding waste from the post-consumer sector will be increasing substantially as older dwellings with vinyl siding are demolished.

Most vinyl siding is guaranteed for life by the manufacturers however most installers maintain that the actual life will vary from as little as 10 years to 30 years or longer, depending on local weathering conditions. Given the growing demand and the amount of time elapsed since vinyl siding was first applied, the amount of vinyl entering the waste stream will increase rapidly in the future, approaching and exceeding current production of 140 kilotonnes per year.

Large manufacturers of vinyl siding indicated they are willing to receive scrap vinyl, especially if the material originated from their facility. Generally, manufacturers as well as installers indicated a need for some form of infrastructure to facilitate the recycling of this material. They also agreed that educating people as to the requirements for effective recycling of vinyl scrap was crucial to the success of any future program.

One of the key recommendations from the manufactures was that it is imperative to keep waste vinyl clean. Many earlier recycling trials failed in part because waste vinyl was often deposited with large quantities of other rubbish. The paper and cardboard recycling industry has had its share of problems in this respect, and has had some success in dealing with the issue through various policies of rejecting and returning loads or refusing entry to the recycling site. The recycled cardboard industry continues to be quite robust despite these problems even with a recycled value of loose cardboard at 5 cents a pound, or less. Some vinyl

siding manufactures have indicated they could process post-consumer vinyl which contained minor contamination, such as nails.

The general comments from the interviews indicate that post-consumer recycling of vinyl siding is possible if a proper infrastructure is established and proper education and communication techniques are utilised. Current landfill rates, which in Ontario range between \$60 and \$90 per tonne, could provide some momentum to diverting this material if alternatives and tools are provided to encourage recycling. There is a strong sentiment from many participants in the interviews that there is a need for recycling but there is no infrastructure in place to accommodate the process. Given the amount of vinyl recycling already taking place in the market place, it is indeed likely that this new stream of supply will be addressed once the infrastructure is developed.

4.3 Windows

Plant tours and interviews were conducted with the major window manufacturing companies in Ontario. It was found that approximately half of the 2% production scrap from the manufacturing of vinyl windows is recycled.

Vinyl waste is also being collected by window fabricators at job sites where existing vinyl windows are being replaced with new windows. The glass is removed from the vinyl frame and recycled, and the vinyl profile is sent to landfill for two reasons:

- there is no way to deal with the high amount of contaminants (sealants, paint, and weather stripping); and,
- the older vinyl is often incompatible with the new formulations of today, thus making the vinyl profile blemished or giving a chalky texture to the surface.

The solution to this scenario is to grind and separate contaminants through water density separations or electrostatic separation systems. This would enable the recovery of a clean vinyl that could be used in a secondary marketplace (e.g. roof vents, pipe grade).

4.4 Wire and Cable

The production scrap generated from wire and cable production varies depending on the type of wire and application use, however 4% has been cited as a typical average figure by interviewed officials. There is little recycling of vinyl or any other insulating material used in the production process except for drool from the extruders. This drool material represents about 25% of the total production scrap.

The remaining 75% of the production scrap is collected and baled and sold to reclaimers who process the scrap for its metal content. Most wire and cable scrap is chopped into finer pieces where the coating and jackets are air separated and the metal scrap recovered. Because of the myriad of plastic materials in the coatings and jackets, as well as the high percentage of metal fines produced by the chopping process, there is little reclaim value in the resulting material.

A relatively small amount of material is processed by stripping the plastic coatings from the wire. It is estimated that 10% of wire scrap is handled this way. As with the chopping method, none of the wire processors interviewed were recycling the separated mixed plastics from this material, however some vinyl recyclers interviewed claimed to receive this material on occasion. This typically occurs if large quantities of a single wire type is processed. The resulting plastic scrap can be reprocessed into a lower grade of material such as carpet underlay or matting. Wire and cable collected from the electronics industry reaches the scrap processor through a number of waste streams such as those associated with precious metal recovery. The wire, including the plastic coatings, is generally remelted and the coatings are considered an additional fuel source.

4.5 Flexible Plastic Sheet Products

Pool Liners

Interviews with manufacturers, processors and installers of swimming pool liners established a production scrap rate of approximately 1%. Approximately half of this production scrap is recycled.

As with vinyl siding installers, the installers of replacement pool liners expressed a high interest in the development of an infrastructure to recycle the old liners. There are approximately 160,000 swimming pools in Ontario. A swimming pool liner typically lasts for 10 years, and weighs 90 kilograms, resulting in an average of 1500 tonnes of pool liners being disposed of each year.

From the point of view of the installers, the key to a successful program is the location of the collection depots. The installers stated that they would recycle the liners if the collection depots were located in close proximity to the installation. However, given the heavy contamination levels associated with the replaced liners, some installers suggested a transfer or landfill location would be a more suitable collection area, as opposed to a wholesaler or distributor of new liners. Further, given the condition of the liners and the quality issues required for new pool liners, it is unlikely that the old liners would ever be utilised in the production of new ones, even on a low percentage blended basis.

Post-consumer recycling of the replaced liners is virtually non-existent as the pool liners are heavily contaminated with mold, dirt and are usually very brittle as a result of UV damage.

Automotive

Interviews were conducted with a number of major autoparts manufacturers who utilise vinyl in various stages of production. The main automotive applications for vinyl are:

- underbody coatings and sealants;
- Wire harnesses (e.g. cable insulation and grommets);
- Passenger compartment parts (e.g. instrument and door panels and arm rests); and,
- Exterior parts (e.g. body side protection strips, weather strips and window sealing profiles).

The recycling of these vinyl components present some challenges as they are generally co-mingled with a number of other materials in the production process. In the companies studied, the chief use of vinyl was in the production of shells which are applied to instrument panels commonly known as dashboards. The scrap rate in this application was low, typically 3%, however the scrap rates vary depending on the section of the automobile it is applied to and the make of automobile involved. In general, the larger the production figure, the smaller the corresponding scrap rate of vinyl material. Scrap vinyl shells typically result from blemishes on the material. This scrap material is baled and sent to a recycler for recovery.

The recycling opportunities become increasing difficult further along the assembly process. Once the vinyl is attached to the rigid portion of the dashboard it becomes co-mingled with foams, adhesives and other plastic materials which increases the level of contamination. The recycling of the co-mingled material has met with variable success and attempts to improve the recyclability of these materials are ongoing. The introduction of alternate and more expensive engineered resins such as TPU and TPO have posed even greater recycling challenges due to a lack of any infrastructure or secondary markets to deal with such new materials. A more detailed analysis of the automotive scrap vinyl recycling process is covered in the Automotive Parts Manufacturing Case Study in Section 7.

4.6 Packaging

A production scrap rate of 8% is assumed from various interviews with packaging processors. Larger processors regrind and reuse almost 100% of their scrap and generally experience lower scrap rates as well. Smaller companies have their scrap removed by recyclers. Overall, approximately 75% of the production scrap from packaging production is recycled. Some material is reprocessed locally, however a considerable amount is exported to the Orient. Most post-industrial scrap packaging materials are clean and homogeneous and easily recycled or reused.

Virtually all of the post-consumer vinyl packaging from the residential sector is landfilled.

4.7 Summary

In total, approximately 60% of the vinyl production scrap generated is currently being recycled. This means that 5000 tonnes or 0.8% of Canadian production of relatively-clean vinyl production scrap is currently being sent for disposal. This is often due to the fact that the vinyl is combined with other materials, but also occurs because a system of vinyl recovery has not been put in place in the production facility.

There is virtually no recycling of vinyl installation scrap or post-consumer vinyl waste, mainly because there is not an infrastructure available to collect and consolidate the material so that it can be sent for further processing.

Section 5: Directory of Vinyl Recyclers

Interviews were conducted with vinyl recyclers located in Ontario and within 150 km of its borders. It was found that the current vinyl recycling capacity within a 150 km radius of Ontario is approximately 70,000 tonnes per year, which exceeds the quantity of vinyl waste currently being generated in Ontario. This capacity is made up of:

- 20,000 tonnes of rigid vinyl recycling capacity; and,
- 50,000 tonnes of flexible vinyl recycling capacity.

A listing of vinyl recyclers in Ontario and within 150 km of the Ontario border is included in Table 5.1.

Table 5.1: Vinyl Recyclers

COMPANY	CONTACT & ADDRESS	PHONE/FAX	COMMENTS
4A Plastic Recycling	Brian Cunningham , 24 Lowrey St S, Cambridge, Ont N1R 4Z3	(519) 621-3040 (519) 621- 1945	grinding, brokering
A&B Plastic Co. Ltd.	Tommy Adler, 269 Rimrock Rd., Toronto, Ont M3J 3C6	(416) 630-4666 (416) 630-7616	cleans, sorts and converts post- industrial scrap
Accom Plastics Ltd.	225 Nugget Ave, Toronto, Ont	(416) 754 3828 (416) 630-7616	will pick up clean scrap vinyl in gaylords
B&G Resins Inc.	John Bagnoley, 880 Oullette Ave, Suite 301, Windsor, Ont N9A 1C7	(519) 254-2013 (519) 254-1523	recycles mainly post- consumer vinyl wastes
Bradex Industrial Services Ltd	Edward Gres 1451 Royal York Rd, Unit 204, Weston, Ont M9P 3B2	(416) 224-8621 (416) 224-6057	recycles vinyl packaging and brokers to hose manufacturers
CCG Parma	Campbell Hendry, 76 Davis St., Simcoe, Ont N3Y 4N5	(519) 426-5544 (519) 426-5132	grinding, washing, baling, brokering/ preconsumer vinyl
CCC Plastics	Les Tabor, Colborne Industrial Park, Colborne, Ont K0K 1S0	(905) 355-2537	recycles pre- consumer vinyl
Conex Polymer Inc.	Frank Gemma, 107 Dowty Road Ajax, On. L1S 2G3	(905) 428 3117 (905) 428 6641	compounding and grinding
Deras International Inc.	Lillian Deras, 5 Washington St, P.O. Box 67, Ellicottville, NY 14731	(716) 699-6085 (716) 699-6007	buys and sells flexible vinyl, manufactures garden hose and shoe soles

COMPANY	CONTACT & ADDRESS	PHONE/FAX	COMMENTS
Double Industries Inc.	Ander Lam, Unit 19, 3001 Markham Rd, Scarborough, Ont M1X 1L6	(416) 292-8077 (416) 292-7593	broker
Enviro-Tech Plastics	Jerrold Carter, 130 Fort St. Amherstburg, Ont N9V 1B8	(519) 736-4458 (519) 736-1081	recycler
Findlay Foam	Jim John, 1831 E. Manhattan, Toledo, OH 43608	(419) 727-8090 (419) 727-9350	grinding, brokering
General Mill Supply Company	Robert Rotenberg, 189 Vinewood Ave, Detroit, MI 48216	(313) 554-1000 (313) 554-1007	grinding, brokering specializes in flexible vinyl
Greenline Resins, Inc.	C. Green, 200 Universal Rd., Woodstock, Ont	(519) 539-0401	grinding, washing, brokering
Geo Polymers	Earl Silver, 7581 Jane St, concord, Ont L4K 1X3	(905) 761-1621	recycles pre-consumer vinyl
Haycore Canada	Paul Wills, 3114 Gregoire Rd., Brockville, Ont	(613) 445-3610 (613) 445-0247	recycles post-consumer vinyl
Hematite, Div of Pavaco Plastic	Ted Jacobs, 229 Speedvale Ave., Guelph, Ont	(800) 488-4274	recycles material into automotive scrap
Intermet, Ltd.	Julius J. Rim, 6000 Buchanan St., Detroit, MI 48210	(313) 894-0545 (810) 737-4142	grinding, shredding, extruding, molding
K&R Textile	Karen Foguth, 317 S. Elm, Owosso Michigan 48867	(517) 723-4928 (517) 723-6064	vinyl & vinyl with foam
Kal-Trading	Gobi Saha 2280 Drew Rd, Mississauga, Ont L5S 1B8	(905) 846-4040 (905)	grinding, brokers to China and SE Asia
Kimco Steel Sales Ltd	Gregg Rosen, P.O. Box 300, Kingston, Ont K7L 4W1	(613) 544-1822	
L&R Bigras Holdings	Ray Bigras, 844 London Rd, Sarnia, Ont N7T 4Y2	(519) 336-7234	recycles post-industrial vinyl
Multi-Plas	Joe Swantack, P.O. Box 6037 (43614), 1802 Nebraska Ave, Toledo, OH 43607	(888) 456-7527 (419) 255-5144	grinding, brokering
Nam Polymers	Ali Lodhi, 1600 Aimco Blvd Ste. 6, Mississauga, Ont L4W 1V1	(416) 679-8765	recycles preconsumer vinyl

COMPANY	CONTACT & ADDRESS	PHONE/FAX	COMMENTS
The Norwich Group	Bill Gosse, 42 Kevco Place Kitchener, Ont N2C 2G5	(519) 653-7373 (519) 893-0123	grinding, sorting, baling, brokering also provide tolling services to an additional 4000 tonnes/year
BSM	Dave Dawson, 95 Norwich Ave, Woodstock, Ont N4S 3V3	(519) 421-2822 (519) 421-0646	
Cambridge Compounders	Todd Fleury, 400 Dolph St, Cambridge, Ont N3H 2A7	(519) 650-4432 (519) 653-4362	
Cryomark Inc.	Bill Gosse, 42 Kevco Pl, Kitchener, Ont N2C 2G5	(905) 276-8660 (905) 275-6013	
Cryo-Vision, Inc.	Shayne Gauvreau, 95 Norwich Ave, Woodstock, Ont N4S 3V3	(519) 533-0581 (519) 533-0582	
Halton Hills Plastics	Gobin Persaud, RR#1, Hwy #7, Acton Ont L7J 2L7	(519) 853-5233 (519) 853-4783	
Norwich Recycling	Bob Reid, 95 Norwich Ave, Woodstock, Ont N4S 3V3	(519) 421-1075 (519) 421-0646	
Ontario Recycling Inc	Paul Kubrich, 12 Cairn St, Rochester, NY 14611	(716) 328-4253 (716) 328-4256	grinding, sorting, brokering
Petco USA	Jean-Luc Lavergne, 8800 Crescent #1, Anjou, PQ M1J 1C8	(514) 354-5757 (514) 354-3087	
Planet Earth Resource Tech, (Systems Challenge)	Pedro Trives, 3151 Lenworth Dr., Mississauga, Ont L4X 2G7	(905) 602-8505	grinding, sorting
Plastic Development International	Sven Larsen, 63 Oakridge Drive, Barrie, Ontario L4N 5N6	(705) 734-0539 (705) 734-9870	rigid vinyl recycler
Polymart Inc.	Mohamed Sabur, 7480 Kimbel St Unit 56-7, Mississauga, Ont L5S 1A5	(905) 672-1470 (905) 672-0144	grinding, sorting, washing, in-house tolling
Proplas Industries Inc	Fred Mastroianni, 2345 Wycroft Rd. Unit 7 Oakville, Ont L6L 6L8	(905) 825-5630 (905) 825-5782	grinding, sorting
PVC Recovery Services Ltd.	Rob Ball 598 Colby Drive Waterloo, Ont N2V 1A2	(519) 884-1961 (519) 884-2010	grinding, fabricating, sorting post-consumer vinyl
Rehau Industries	Tom Farrell, 1149 Pioneer Road, Burlington Ont L7M 1K5	(905) 825-0143	post-consumer vinyl
Schlegel Systems Inc.	Lee Janowski, 1555 Jefferson Rd, Rochester, NY 14623	(716) 427-7200 (716) 427-7216	redensifies material
Simcoe Plastics Ltd.	W.L. Wheeler, 7089 Yonge St, Thornhill, Ont L3T 2A7	(905) 881-1505 (905) 881-9389	brokering post-consumer vinyl
Sinosyntax Recycling Centre	Walter Lai, 8620 Disputed Rd, LaSalle, Ont N9A 6L6	(519) 252-9083	post-consumer vinyl

COMPANY	CONTACT & ADDRESS	PHONE/FAX	COMMENTS
Solid Waste Reclamation Inc.	P.O. Box 200 Station "A", Hamilton, Ont L8N 3A2	(905) 523-0036 (905) 523-6036	brokering
Soverinsky & Son Inc	Ralph Soverinsky, 189 Vinewood St, Detroit, MI 48216	(313) 554-9110 (810) 646-0231	grinding specializes in flexible PVC
Terrence Commerce, Inc.	Wilson Ho, 45A Wilmot St, Suites 203, Richmond Hill, Ont L4B 2P3	(905) 709-2981 (905) 709-2982	brokering
Turtle Island Recycling	Vince Fernia, P.O. Box 6762 Stn "A" Toronto, Ont M5W 1X5	(416) 406-2040 (416) 406-2044	

Section 6: Barriers to Vinyl Recycling

Any recycling program, regardless of the material being recycled, requires the following conditions in order to be successful:

- a stable source of supply;
- close proximity to waste generation;
- clean, consistent material;
- the ability to identify materials;
- reliable, economical end markets;
- an infrastructure of collection and delivery; and,
- economic viability.

These conditions are much easier to satisfy for post-industrial wastes, and as a result, a high percentage of post-industrial vinyl is being diverted from disposal.

The recycling of post-consumer vinyl products presents some challenges as well as opportunities for the future. As was demonstrated in Section 2, most vinyl products are still in useful service so there has not been a sufficient supply of vinyl waste available to stimulate a market. However, the quantity of post-consumer vinyl waste will increase significantly in coming years and it is imperative that the barriers outlined in the following sections be addressed in order to prepare for this situation.

6.1 The Current Short Supply of Vinyl Wastes

The market for post-consumer vinyl scrap has not had time to develop due, in part, to the durability of vinyl products and their relatively recent introduction into the marketplace. This study has not uncovered any significant recovery program for post-consumer scrap vinyl from the residential sector currently operating in Ontario, mainly due to the small quantities of vinyl waste being generated from the household on a regular basis.

A study conducted at the consulting firm, Enviro RIS, on the generation of vinyl waste in the residential sector determined that there is very little vinyl in the waste stream.

Enviros RIS PVC Residential Generation Data

Location	Generation (kg/hh/yr)	Description
Barrie	0.85	Dec '94 – 46 hhs for 3 weeks
“	0.92	June '95 – 46 hhs for 3 weeks
“	1.38	Oct '95 – 46 hhs for 3 weeks
Etobicoke	0.98	Oct '96 – 48 hhs for 4 weeks
Hamilton	1.07	Mar '95 – 60 hhs for 3 weeks
Markham	0.53	Apr '95 – 32 hhs for 3 weeks
“	0.90	May '95 to May '96 – 160 hhs each month
“	0.79	July '96 – 40 hhs for 3 weeks
Muskoka	0.94	Sept '95 – 30 hhs for 1 week
North York	0.75	June '94 – 40 hhs for 1 week
Richmond Hill	0.72	Feb '96 – 129 hh for 3 weeks
Brantford	0.72	Nov-Dec '96 – 42 hhs for 3 weeks

The above study (courtesy of Enviros RIS) shows selected areas of the province along with the quantities of vinyl waste generated per household. The waste composition study shows that there is between 0.53 to 1.38 kilograms of post-consumer vinyl scrap generated per household per year. This is significantly less than the quantity of recyclables that are collected in traditional blue box programs, and represents *approximately 0.1%* of the total residential waste stream.

Except for a few pilot projects, there has been little recovery of post-consumer vinyl waste from the household because of the small quantity of material.

6.2 Separating Vinyl from Other Plastics

This is one of the more challenging opportunities for increasing the diversion of vinyl or any other plastic from the waste stream. The easiest method of separation is to not co-mingle different plastics in the first place. However, there are situations where it is not feasible to perform this function. Usually this applies to situations where the volumes generated do not permit the viability of source separation. There are other situations where the vinyl is physically attached to another material making separation difficult. There are emerging technologies such as cryogenics that have had some success in separating co-mingled

plastics on an industrial scale. Other technologies employing density, optical electrostatic and air separation achieve up to 99% clean separation of materials. These technologies are expensive, however, and are generally limited to high value vinyl materials.

These new separation methods, along with emerging chemical processes, will likely develop to meet the challenge as the supply of post-consumer vinyl waste increases in the future.

6.3 Additives Used in Vinyl Products

As with other plastics, there are additives used to enhance the suitability of vinyl in certain applications. The additives control stability, flexibility, hardness, clarity, colour, conductivity and many other properties of the vinyl material. The main additives are stabilizers, plasticizers, and fillers. Each vinyl product has various combinations of additives to meet the specifications required for each application. The versatility of vinyl is due, in part, to the relative ease of varying these components to meet changing requirements of a particular application over time. It is important that the properties of scrap vinyl be known if it is to be reused or recycled into another product. This explains why scrap vinyl is so easily recycled at the production level. The additive matrix in a post-consumer vinyl may not be known so the material must be down-cycled into a material where the specification is more tolerant of variation in the matrix.

This also underlines the importance of source separation programs when dealing with vinyl before it becomes part of the waste stream. Given vinyl's versatility, any vinyl scrap material can be reused or reclaimed by altering its chemical structure accordingly when recompounding. The key prerequisite to maximise the economics of the process is a stable supply of material where the chemical and physical properties are known and consistent.

6.4 Contamination of Vinyl with Other Materials

It is important with vinyl recycling, as with other polymers, that the material be free from other contaminants. However, due to the types of applications that are typical for vinyl, these products are often heavily contaminated with glass, metals, and dirt. In addition, the vinyl itself may be degraded due to weathering. Currently the bulk of these materials are disposed of with other construction and demolition materials in designated landfills and transfer facilities.

As the quantity of post-consumer vinyl products in the waste stream increases, it will become more viable for companies to invest in the separating equipment (i.e. optical, density, electrostatic and air) that can automatically sort the vinyl from other materials.

6.5 Economic Collection of Vinyl Products

Manufacturers of vinyl products have indicated a willingness to recycle other vinyl wastes, however they emphasise that the collection system is not adequate to address the quality issues.

In the United States, the Vinyl Institute, the Vinyl Siding Institute and the National Association of Home Builders (NAHB) joined a group of vinyl siding distributors and installers to form the Grand Rapids Recycling Initiative. This group intended to conduct a six-month pilot project to recycle vinyl siding from construction sites. By the time the six months had passed, the program had become so popular with vinyl siding installers and retailers that the participating distributors decided to continue collecting the material. To date, more than 120,000 pounds of vinyl siding from Grand Rapids construction sites has been collected and recycled into mobile home skirting by StyleCrest, Fremont, Ohio. The skirting has a 30% to 100% recycled content in the substrate. Data collected during the "pilot" program was used in an NAHB construction recycling handbook

The study has uncovered a willingness among some installers to recycle vinyl material, particularly siding. The main recommendation from the pilot project was that a segregated area be established to receive vinyl at landfills or transfer facilities. This allows for convenient collection points for vinyl recovery.

Many operatives in the waste haulage business are sceptical of vinyl recycling since past experimentation with other materials (i.e. paper and cardboard) resulted in high levels of contamination. Given the sensitivity of any plastic material to contamination, most of the haulers interviewed felt this option was unworkable, especially given the current low cost of landfill and the relatively low value of the scrap vinyl which must be separated, transported, washed and reground prior to reprocessing. It should be mentioned that support for recycling has been rather mixed by some in the waste haulage industry with opposing philosophical attitudes on a wide range of issues, but generally focused on the additional cost of recycling in general. Regardless of the status of the debate to date, there is no infrastructure currently in place to collect post-consumer vinyl material in Ontario.

The waste haulage industry in Ontario is generally geared to transport the solid waste it collects directly to landfill. Unless mandated otherwise, as in the case of paper and cardboard, most material collected as solid waste is sent to landfill. Interviews with principals in the haulage industry reveal that most haulers must commit to a guaranteed landfill tonnage to establish a discounted tipping fee. There is therefore little incentive for culling a given material from the total waste collected unless the value of the material is substantially greater than the cost involved in separating it from the waste stream.

6.6 *Inexpensive Disposal Costs*

The cost of disposal is a function of the local landfill tipping fee and the transportation cost. In Ontario, landfill transport and disposal costs are typically in the range of 10 cents to 12 cents per kilogram. This figure can be higher for lighter materials and lower for denser materials because of the transportation element of the cost. As the cost of tipping fees increase, recycling becomes a more attractive alternative.

Ontario Regulation 103/94 requires that certain materials, such as brick, drywall, steel and wood be separated out and recovered from construction and demolition projects. If a collection infrastructure for vinyl waste were in place, this regulation could be expanded to include vinyl scrap and products, and the amount of vinyl waste going to landfill would be significantly reduced.

In the case of post-industrial vinyl scrap, the cost of disposal helps to encourage recycling. There is more control over the waste generation process and the quantities of scrap are usually sufficient to supply the economies of scale required to reprocess the material. The material ingredients are known and are relatively free of contaminants which may interfere with the production process and inhibit the economic benefit of using reclaimed vinyl. These factors readily explain the popularity of recycled vinyl in the post-industrial setting.

Section 7: Case Studies

Following the discussion of barriers to vinyl recycling presented in Section 6, it is important to look at some situations where the challenges of recycling have been overcome, and successful vinyl recycling programs have been put in place. This Section outlines two case studies of successful vinyl recycling operations.

7.1 Post-consumer Vinyl IC Tubes Case Study

The following case study outlines post-consumer recycling of vinyl integrated circuit (IC) tubes and blister packaging in a large electronics manufacturing facility with over 3000 employees. Given the anticipated volume of post-consumer vinyl to enter the waste stream in the near future, this example is selected to demonstrate that post-consumer vinyl recycling is economically sustainable in a manufacturing establishment.

The 10,000 square metre facility located in Toronto operates on a 24-hour basis, seven days a week and maintains full production capabilities around the clock. The company provides manufacturing technology and service solutions for printed circuit assembly and system assembly, as well as post-manufacturing support to many of the world's leading original equipment manufacturers. The company's goal is to be the "technology partner of choice in the electronics industry." Due to the breadth and depth of the company's services, they are able to satisfy customer requirements, which range from low volume, high complexity custom products to high volume commodity products. The company is presently one of the largest electronics manufacturing companies in the world, and is still growing rapidly.

The company's waste stream consists of a substantial quantity of packaging waste used to ship electronic components from all over the world. Among other plastics, there is a large proportion of vinyl IC tubes, as well as vinyl clam shell blister pack material used to package the electronics parts used in production. In the past this material was collected along with other waste by maintenance staff and conveyed to a waste compactor where it was eventually landfilled. The company had numerous recycling programs in place to deal with the more traditional substances such as organics, paper fibre, cans and glass. Numerous waste audits in the past had observed the significance of the plastic packaging waste which represented more than 50% of the waste generated by volume. However there was no infrastructure in place to deal with the co-mingled vinyl material along with other plastic packaging that often appeared identical.

A solution was found after numerous consultations with outside recycling experts. In order to divert the vinyl material from landfill it would be necessary to source separate the material from the waste stream so it would be free from contamination with other plastics. This was achieved by isolating the source areas of generation and collecting it separately. Given the volume of the material, this process added little to the workload of the maintenance staff as the material had to be removed from the plant floor anyway and given the volume all that was required was minor adjustment to the collection process. This simple process removed a major barrier to the recyclability of this material by removing the cost of separating the material from the other plastic.

The vinyl packaging waste had to undergo a number of additional steps before it became economically feasible to recycle. It was necessary to purchase a small baler that densified the lightweight packaging materials into compact bundles. This saved additional cost as the baler achieved far greater compaction ratios than could be achieved in the waste compactor, thus avoiding extra pick ups and landfill tipping fees. It also helped reduce the recycling cost as transportation cost was greatly reduced when dealing with baled materials.

There were a number of drivers that produced the conditions necessary to develop a program to remove vinyl material from the waste stream. As these are developing and becoming applicable to other industries, they are cited as follows:

- The program was implemented and maintained to reduce the risk of liability and non-compliance with Province of Ontario Regulation 102/94.
- The program was implemented and maintained as a result of social pressures exerted by the employees and customers.
- The program was implemented and maintained to gain competitive advantage over the company's competitors.

Recent developments in environmental awareness and responsibility have put increasing pressure on corporations to address the growing awareness of environmental issues by other stakeholders. A casual review of the annual report of any major corporation will always reveal some mention of the company's commitment to environmental values. As in this example, the drivers behind the initiative were not solely based on cost but on the changing values of society as a whole. The realisation that the initiative is cost sustainable will only serve to maintain the program into the future as well as initiate new environmental activities.

There were also barriers to the implementation of the program that will be briefly outlined, as they are probably common to other companies with initiatives of this nature. The main barriers were:

- A barrier to the development and success of the program was the risk and uncertainty of finding end markets for recyclables, and with altering the production process.
- A barrier to the development and success of the program was the lack of awareness by management of available waste reduction strategies, as well as the “old-style” thinking by management which assumed an “if it ain’t broke, don’t fix it” attitude.
- A barrier to the development and success of the program was the lack of awareness by employees of an existing program or of its correct procedures for implementation.
- A barrier to the development and success of the program was that decisions that do not save money are not typically implemented.

There were also external barriers to overcome in dealing with the IC tubes. Many suppliers use a thermoset rubber or nylon stopper at each end of the tube to retain the parts. They also paste a paper identification label on the tube resulting in additional washing to remove the label in the recycling process. Though new sorting technology is proving effective in dealing with most contaminants, it would be simpler to avoid these unnecessary steps by designing the tubes for ease of recycling. Some suppliers of electronic parts are specifying that the ends of the tubes be crimped so as to avoid the use of a stopper insert. The use of vinyl, as opposed to paper, identification labels would also improve the recyclability of the IC tube as well as other vinyl packaging material.

With proper management, education and communication, the above barriers were overcome and approximately 20 tonnes per month of vinyl is now being diverted from landfill. The vinyl collected is reground and compounded back into pellets and blended with virgin material to make new products, including vinyl IC tubes.

7.2 Automotive Parts Manufacturing Case Study

This case study was conducted with one of the largest users of flexible vinyl in the automotive industry in Ontario. A review of the in-house recycling program determined the following components needed to be incorporated into the program to increase its effectiveness:

- A system of communicating the goals of the recycling program and gaining support for the program from all employees;
- Involvement of the material recycler in the in-house system of separation, collection, and education of employees;
- An efficient method of material collection and handling; and,
- A method of tracking the materials recovered.

One of the largest barriers found in this company was the lack of knowledge throughout the facility. For example, most employees were unfamiliar with new technologies available in the recycling world. The second most common problem was keeping the specific materials separate from other similar materials. Many manufactured parts had other polymer structures either laminated to it, or attached. Due to the high contamination level, this material was destined for landfill. Other problems were created by recyclers not meeting the challenge to recycle all of the material from the facility. In other words, the recyclers would “cherry pick” the commodities that would suit their needs, and ignore the more complex material.

The first step in designing and developing a successful recycling program was to have support from all upper management. A representative from each aspect of the company was selected for the recycling committee. The committee members played an important role in educating the people around them. If questions arose, people got quick answers from a committee member.

The committee designed and developed the collection and tracking systems that would suit their needs. They were involved in the initial setup of the program, included design of the signage at all source separation points.

The recycler’s role was to educate the committee so that each committee member was fully aware of all aspects of the recycling program. The recycler should be able to meet all the challenges and demands of the recycling industry, and know how to direct the difficult materials to the processing stage. A recycler should be keen to all end markets, and not just the markets that are most economically attractive.

It was found that the previous recycling collection system that was developed in the early 1990’s was missing a couple of key elements. One of the most important elements was moving the material throughout the system efficiently. By increasing the load size from 10,000 lbs. to 40,000 lbs., the freight costs were reduced by 75%. This 1.5 cent per pound reduction in freight costs helped to make the recycling of the vinyl waste more economically viable.

To maximize the efficiencies, the material was compacted, by either baling or with a compaction bin. The balers were installed in the areas where large volumes of waste materials were generated to improve efficiencies. Densifying the material reduced in-house handling cost by over 50% by eliminating the unnecessary use of fork trucks to shunt loosely-packed containers around the plant floor.

Another important factor was the lack of tracking of materials recovered. It was difficult to gauge the success of a program without a proper tracking system. In order to improve tracking, bales of the collected materials were weighed and an average weight per bale was determined. After that it was only necessary to count the bales to establish an effective estimate of the recovery process.

Section 8: Directory of Products Containing Recycled Vinyl

There currently exists a strong demand for recycled vinyl. The benefits of using recycled vinyl are that basically the same properties can be achieved as with virgin resin (i.e. durability, resistance, ability to withstand the elements). In addition using recycled vinyl may be more economical than using virgin resin.

A major directory of products containing recycled vinyl, and the names and addresses of the distributors can be obtained from the internet at www.plastics.ca/epic.

The major applications for use of recycled vinyl are garden hoses, shock-absorption pads, sound barriers, roof vents, sewer pipes, and skirting for manufactured homes. Many of the new applications for recycled vinyl are in the marine industry since vinyl can withstand the harsh environment without leaching, rotting, cracking, or crumbling.

Flexible Products	artificial underwater reefs (BIOreef®)
	automotive parts
	binders
	bumpers
	carpet backing
	chequebook covers
	clothing
	coasters and trivets
	computer mousepads
	erosion control
	flooring
	garden hoses
	ladder treads
	marine bulkheads
	non-electrical cable coatings
	rail rollers
	shock-absorption pads
	shoes, soles
	sound barriers
	surfacing material
tarps	
wear pads	

Rigid Products	bottles
	coasters and trivets
	computer keyboards
	core materials for other applications
	electrical conduits
	erosion control
	fencing
	flower pots
	furniture components
	industrial sheeting
	irrigation pipe
	landscaping materials
	piling protection
	retaining walls
	roof vents
	sewer pipes
	skirting for manufactured homes
	water flow directors
	wave breakers
window profiles	

Section 9: Conclusions and Recommendations

It is our observation that there is a large quantity of vinyl production scrap that is currently being reground in-house or is tolled by contracted recyclers and returned for reuse by the original producer. Because this material does not go through a change of title, it has not been included in the vinyl waste addressed in this report. If the tolled and in-house recycled vinyl were included as a part of this study, the percentage of production scrap that is recycled would increase significantly.

Based on this study of vinyl products and wastes that do have a change of title, the following conclusions can be made:

1. The main applications of vinyl are in long-life products that have an expected lifespan of 10-100 years.
2. Because of the longevity of vinyl products, there has been very little post-consumer vinyl in the waste stream until recently.
3. The amount of post-consumer vinyl waste will increase exponentially in the coming years.
4. The technology exists to recycle vinyl into both high-end applications and lower-grade products.
5. New separation technologies are able to achieve up to 99% purity in separating vinyl from a commingled polymer stream.
6. Approximately 60% of vinyl production scrap that undergoes a change of title is currently being recycled. This excludes internal regrinding and tolling. As a result only 0.8% of the vinyl produced in Canada ends up as production scrap for disposal in landfill.
7. An in-house source separation program for production scrap is the most cost effective method to recover vinyl.
8. Installation scrap is typically not recycled because the infrastructure does not exist to collect and consolidate the material.
9. There is virtually no post-consumer vinyl waste currently being recycled because the infrastructure does not exist to collect and consolidate the material.

10. There are many applications for recycled vinyl, and the demand for recycled vinyl is currently high.

There are many challenges that must be addressed in order to increase the diversion of vinyl wastes, both now and as the amount of vinyl in our waste stream increases in the future. The implementation of the following recommendations would assist in increasing vinyl recovery:

1. Plastics recyclers should prepare for the large increase in the quantity of post-consumer vinyl products that will be entering the waste stream in the coming years. This may involve investing in equipment that can mechanically separate vinyl from other materials or contaminants.
2. The vinyl industry should study the degradation of vinyl over time and the impact that this degradation has on reformulating waste vinyl into new products.
3. A system of identifying vinyl waste would assist recyclers in segregating vinyl compounds. It is important that any labelling system not add to the contamination of the vinyl waste, therefore the identifying label should either be made of the same vinyl compound as the product, or be stamped directly into the product.
4. An infrastructure to collect and consolidate installation scrap and post-consumer vinyl waste is needed. Segregated areas could be set up for the collection of vinyl wastes, separate from other waste materials. Landfills, transfer stations and builder supply yards are recommended locations for such collection points.
5. *Ontario Regulation 103/94* requires the separation for recycling of a list of certain recyclable commodities, such as drywall, steel, and wood, from construction and demolition sites. Once an infrastructure is established for collecting and transporting vinyl waste, the list of mandatory recyclable commodities could be expanded to include vinyl waste from construction and demolition projects.