SNC·LAVALIN

FINAL REPORT

RESOURCE RECOVERY FUND BOARD INC.

Nova Scotia Glass Study

SNC-Lavalin Project No. 017075-0001

November 2006

Certified ISO 9001

Final Report

Nova Scotia Glass Study

Prepared for:
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November 8, 2006

Resource Recovery Fund Board Inc.
14 Court Street, Suite 305
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Attention: Mr. Dale Lyon
Executive Assistant

Dear Mr. Lyon:

RE: Draft Report – Nova Scotia Glass Study

Please find enclosed twelve hardcopies and an electronic copy of the final report for the Glass Study that investigates reliable end markets for post-consumer glass recycled in Nova Scotia.

If you need any additional information or have any questions, please do not hesitate to contact me at (902) 492-4544.

Yours very truly,

SNC-LAVALIN INC.

David Haley, P.Eng.
Manager – Environmental Services

DH/mmt

Enclosures

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EXECUTIVE SUMMARY

SNC-Lavalin Inc. was retained by the Resource Recovery Fund Board (RRFB) in January 2006 to study potential markets for post-consumer glass recycled in Nova Scotia and determine the processing requirements for supplying cullet and/or glass sand to feasible markets.

As an initial step, a review of emerging markets for recycled glass in North America was completed. Potential markets included:

- Sandblast material
- Wastewater filtration in septic beds
- Water filtration
- Roadbed aggregate
- Specialty asphalt
- Daily landfill cover and landfill construction
- Gardens, landscaping, and walking trails
- Reflective beads for road paint
- Fibreglass insulation
- Winter sand/salt mix for roads
- Container manufacturing

Information was collected regarding the quantity of processed glass available in Nova Scotia. SNC-Lavalin personnel then contacted municipal and provincial government agencies and private companies in Nova Scotia to determine if there would be an interest in using recycled glass in their operations, based on the potential list of markets gathered through the review process.

Considering Nova Scotia, the investigation of emerging glass markets indicates that the potential uses for post-consumer glass that may be:

- Container manufacturing (Owens Illinois);
- Sandblast material (Shaw Resources and Lunenburg Foundry);
- Roadbed aggregate (Nova Scotia Department of Transportation);
- Daily Landfill Cover and Landfill Construction (Municipal Landfills);
- Walking trails (Lunenburg and Halifax Regional Municipality at Second Lake);
- Wastewater filtration in septic beds (Nova Scotia Environmental and Labour); and
- Winter sand/salt mix (Nova Scotia Department of Transportation).

Based on discussion of the market research with RRFB personnel, it was recommended that further investigation regarding processing requirements for applicable local markets be conducted.

Our research has indicated that preliminary design and costing for glass processing requires an understanding of the levels of contaminants in the glass feedstock to be processed and the final specification of the end product. Since quality of the post-consumer glass was not available, a detailed equipment list and related costing could not be developed for potential markets. However, degrees of processing were established based on the end products (cullet/sand with some or high levels of contaminant removal).

Results of the processing requirement analysis indicated that sub-base applications such as roads and walking trails have the lowest processing cost since contaminants are often not a major concern. The second lowest processing requirement is for wastewater treatment septic bed applications since only some contaminant removal is required. Applications such as sand blasting, winter sand/salt mix, and sand for walking trails are expected to have a higher cost due to higher contaminant removal and more refined crushing requirements. Container manufacturing is expected to have the highest processing cost since colour separation is required in addition to a high level of contaminant removal and crushing.

Discussion with RRFB personnel has indicated that the glass sorted at the Enviro Depots in Nova Scotia may have a low level of contaminants and only require size reduction and screening to meet the container manufacturing specifications. Equipment required for processing would include a crusher, conveyors, and multiple screens. SLI recommends conducting a pilot study to determine if this combination of equipment can process Enviro Depot glass that meets the specifications for the container glass industry.

1. INTRODUCTION

SNC-Lavalin Inc. was retained by the Resource Recovery Fund Board (RRFB) in January 2006 to investigate potential markets for post-consumer glass recycled in Nova Scotia and determine the processing requirements for supplying cullet and/or glass sand to feasible markets.

Obtaining reliable and economically viable markets for post-consumer glass has been difficult for municipal and private glass recycling organizations since glass first began to be diverted from Nova Scotia landfills more than a decade ago, and has been a problem since recycling of glass became mainstream in Ontario in the 1980's. The RRFB has provided a leadership role in ensuring that recycled materials banned from landfills, such as glass food and beverage containers, continue to benefit from sustainable end-markets. This study was developed to identify potential options for glass recycling.

1.1 OBJECTIVES

The objectives for this study were:

1. Review the current glass recycling methods in place in Nova Scotia;
2. Research and investigate new and emerging markets, both local and out of province, that may be viable for post-consumer glass from Nova Scotia Recycling Facilities and/or RRFB; and
3. Investigate the equipment and associated costs required for processing glass to meet the requirements of available markets.

2. APPROACH

Interviews with government agencies, private glass recyclers, and municipal and private Material Recovery Facility (MRF) operators were conducted to determine the amount of post-consumer glass waste materials currently generated in Nova Scotia and evaluate current methods and costs for processing glass. Information gathered from research and the interviews included the type, quality and quantity of glass received from the waste stream, the method of processing, end-uses for the recycled glass and technical barriers.

To determine potential markets applicable to glass recycling in Nova Scotia, a review of emerging markets for recycled glass in North America was completed which included the use of glass in:

- Sandblast material
- Wastewater filtration in septic beds
- Water filtration
- Roadbed aggregate
- Specialty asphalt
- Daily landfill cover and landfill construction
- Gardens, landscaping, and walking trails
- Reflective beads for road paint
- Fibreglass insulation
- Winter sand/salt mix for roads
- Container manufacturing

Interviews were conducted with personnel in other Canadian provinces and the United States to obtain a description and location of glass markets, processing requirements, regulatory criteria, financial implications, technical barriers, and public perception.

SNC-Lavalin personnel then contacted municipal and provincial government agencies, and private companies in Nova Scotia to determine if there would be an interest in using recycled glass in their operations.

3. CURRENT GLASS STRATEGY IN NOVA SCOTIA

3.1 ESTIMATE OF ANNUAL GENERATION OF WASTE GLASS

There are two streams of residential post-consumer glass that are source-separated in Nova Scotia, refundable and non-refundable glass. Refundable glass includes all beverage containers, with the exception of dairy product containers, that are handled through 84 Enviro-Depots throughout the province (NSEL, 2004). Non-refundable glass includes all other household glass that is handled through the blue bag program, such as food containers, glasses, etc.

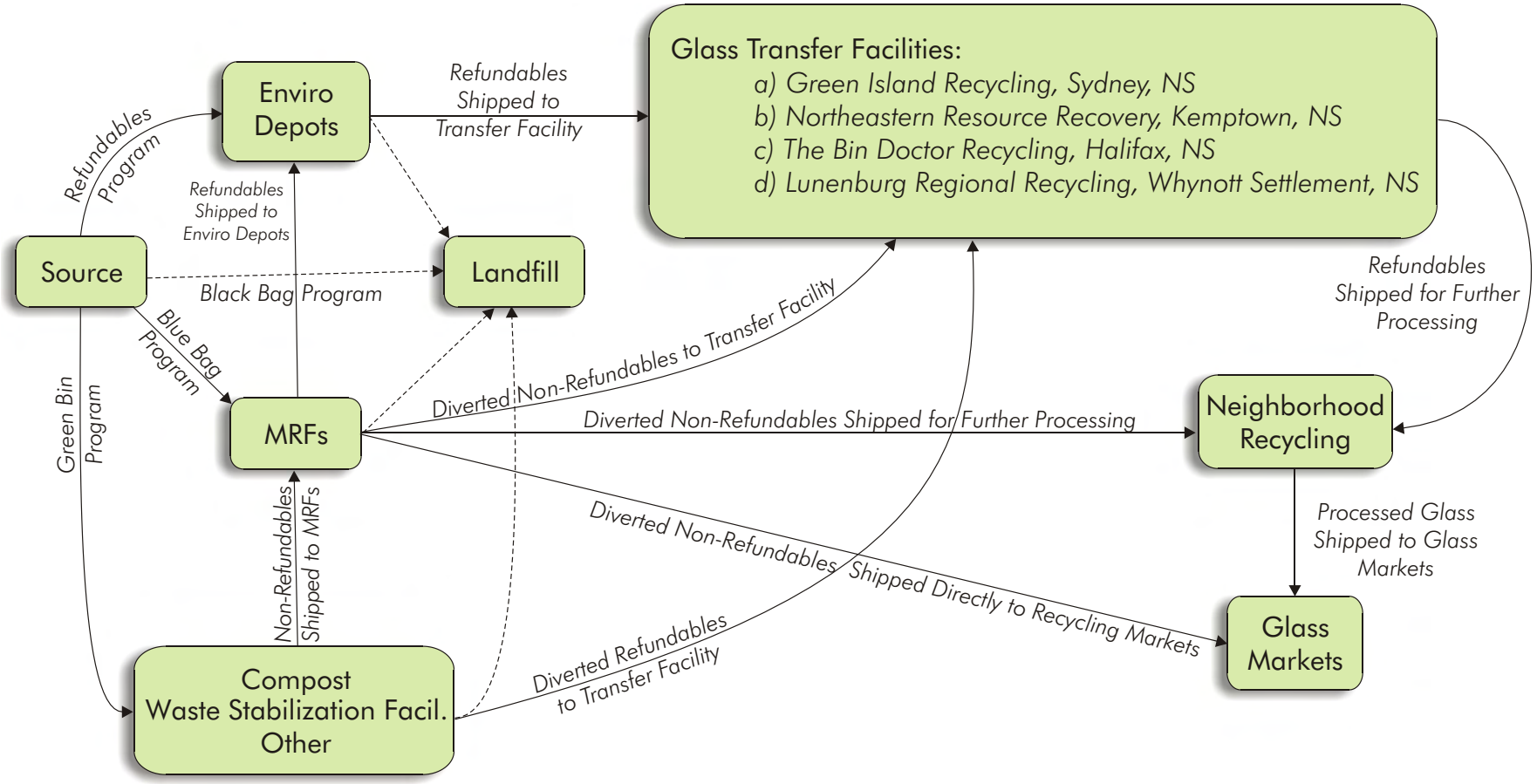
According to information on the quantities of post-consumer glass received from Nova Scotia Environment and Labour (NSEL) and RRFB, there were approximately 11,500 tonnes of post-consumer glass generated in Nova Scotia in 2004. This amount includes 11,000 tonnes of refundable glass from the RRFB Enviro-Depot deposit program and approximately 500 tonnes of non-refundable glass reported from the municipal MRFs. NSEL and RRFB representatives have indicated that reported quantities are inaccurate.

Other sources of glass in Nova Scotia include the ICI sector, such as windshield glass, windows, etc. NSEL estimates that there are between 1,000 and 1,200 tonnes of waste windshield glass generated annually and up to 12,000 tonnes of waste commercial glass from distributors such as Kohler and Atlantic Glass.

Post-consumer glass is also disposed in black bags and ends up in landfills. According to NSEL, 701,905 tonnes of solid waste was generated in Nova Scotia during the 2004/2005 fiscal year. Of that total, 268,055 tonnes was diverted to various programs, such as recycling, and 433,850 tonnes was disposed of in provincial landfills. Data from waste audits conducted in the province indicate that typical amounts of glass in black bag waste in Nova Scotia range from 1-2%. It is therefore estimated that there may be between 4,300 to 8,600 tonnes of post-consumer glass that is currently not source-separated. It is not known how much of this amount consists of refundable, recyclable or ICI glass.

Because accurate data on post-consumer glass is not readily available, it was decided by the project group that the study should focus on the emerging markets for waste glass and potential opportunities for Nova Scotia, and to assume an estimate of 12,000 -15,000 tonnes of post-consumer glass available annually in Nova Scotia. This amount comprises 11,000 -12,000 tonnes from Enviro-Depots and 1,000 -3,000 tonnes from other sources such as local MRFs, and other waste sorting facilities (WSFs). These quantities do not include potential waste ICI glass. An illustration of the flow of post-consumer glass and related quantities is illustrated in Figure 3-1.

Figure 3-1: What Happens to Post-Consumer Glass in Nova Scotia



3.2 RECYCLING OF POST-CONSUMER GLASS IN NOVA SCOTIA

Refundable post-consumer glass cullet (broken or whole glass) is sorted at the Enviro-Depots according to colour (clear and mixed), stored in blue plastic bins, and shipped to one of four regional transfer facilities in Nova Scotia:

- The Bin Doctor Recycling, Halifax;
- Lunenburg Recycling, Whynott Settlement;
- Northeastern Resource Recovery, Kemptown; and
- Green Island Recycling, Sydney.

Each transfer facility ships the blue bins on trailer trucks supplied by Neighborhood Recycling to their processing plant located in Scoudouc, NB. Here the coloured glass is processed for sale to Owens Illinois in Scoudouc, NB and the clear glass is shipped to Montreal, QC.

Non-refundable post-consumer glass cullet is recycled through the blue bag recycling program and collected by each municipality's curbside collection system. The material is delivered to a material recycling facility where it is sorted and bulked. Staff at Halifax Regional Municipality indicates that during the 2004/2005 fiscal year approximately 225 tonnes of glass was shipped to Neighborhood Recycling in Scoudouc, NB. It is believed that glass from other municipalities is either sent to Scoudouc, NB or to a regional transfer facility.

4. EMERGING MARKETS FOR RECYCLED GLASS

To determine potential markets applicable to glass recycling in Nova Scotia, a review of emerging markets for post-consumer glass in North America was conducted. The emerging markets were reviewed with respect to potential markets in Nova Scotia, based on factors such as amount of glass required, type of processing required, end-use of product, and potential markets. The sections that follow outline all of the emerging markets identified and discuss the relevance to local use.

4.1 SANDBLAST MATERIAL

Sandblasting is a process that uses compressed air at high pressure to blow fine sand or other abrasive material through a spray nozzle. The abrasive particles erode the surface they are directed towards and leave a clean, matte profile.

Typically, the material used for artificial sandblasting is sand of a uniform size. Other materials for sandblasting include glass beads, metal pellets, dry ice, powdered and powdered slag. Ground coconut shells or dry corn have also been used to produce distinct surface finishes.

Shaw Resources Ltd. in Shubenacadie, NS attempted to process a glass sandblasting media for use in the autobody industry. This attempt was unsuccessful due to a lack of supply of glass feedstock. Enviroglass Ltd., their glass supplier at the time of the trail, stated they could supply 10,000 tonnes of crushed post-consumer glass; however, Shaw Resources only received 300 tonnes of glass to process before Enviroglass went out of business. According to Shaw Resources, the glass was not cleaned to their specifications and the grain size was too large for the sandblasting industry.

Shaw Resources Limited has a silica mill that can process crushed glass to the specifications required for sandblasting autobody work. According to personnel from Shaw, the autobody trade requires sandblasting mesh sizes of 20-40 and 30-60. Shaw Resources would be interested in accepting crushed glass if it was clean and ground to between ¼" minus and ½" minus. They would further process this cullet in their silica mill, then dry and screen the processed "glass sand" for their specific application.

Potential Application for Nova Scotia: Yes

4.2 WASTEWATER FILTRATION IN SEPTIC BEDS

Sand filter septic treatment systems typically consist of a septic tank, a sand media filter, and a drain field. The wastewater flows into the septic tank where solids settle to the bottom. The top effluent flows through the sand filter to a disposal field where it infiltrates into the ground. The filter reduces the rate of effluent flow and provides a place for microorganisms to break down organic matter and pathogens.

According to the Clean Washington Centre (CWC), research indicates that crushed glass filters perform as well as sand filters in the treatment of sewage effluent. The treatment parameters studied included five-day biochemical oxygen demand (BOD_5), fecal coliform count (FC), total suspended solids (TSS), oil and grease (O&G), and nitrates (CWC, 2001)

Research conducted by the Department of Civil Engineering at Dalhousie University investigated the use of crushed glass in recirculating biofilters (RBFs). The filter sand and crushed glass used had a similar effective size (d_{10}) of 1.5mm and a uniformity coefficient of 2. The results showed that crushed glass could be an effective medium in RFBs since the crushed glass filter produced stable effluent BOD_5 and TSS concentrations of less than 20 mg/L. (Gagnon, G. & Hu, Z., 2006)

NSEL are currently reviewing applicable regulations regarding on-site sewage disposal systems, and are considering modifying the specifications to include glass sand.

Potential Application for Nova Scotia: Yes

4.3 WATER FILTRATION

Similar to wastewater filtration, water treatment often utilizes sand filters to remove bacteria, suspended solids and other contaminants. Filters have the potential to remove water contaminants by physical processes such as straining and sedimentation, chemical adsorption, and biological processes.

Research conducted by the Department of Civil Engineering at Dalhousie University compared crushed glass to silica sand for dual media filtration. It was found that the crushed glass in this study had a higher angularity and a slightly higher uniformity coefficient than the sand tested. In general, the particle removal capabilities of the crushed glass filter were slightly poorer than those of the sand filter, as quantified in a field application trial implemented in the community of Orangedale, NS. (Gagnon, G. & Rutledge, S., 2002)

The Halifax Water Commission (HWC) was contacted regarding the possibility of using glass in municipal potable water treatment processes, specifically to replace sand filters. HWC indicated that sand filters are not replaced very often, perhaps just topped up, and sand media can normally be used for more than 50 years before replacement is required. The modern trend in the water treatment industry has focussed on membrane filtration rather than filter media. Our contact was not aware of any new facilities being built that include sand filters. In addition, any media that would be used for potable water supply would have to undergo a stringent certification process before it could be utilized in the design.

Potential Application for Nova Scotia: No

4.4 ROADBED AGGREGATE

Post-consumer glass that has been crushed and screened has the potential for use as a granular base material for road and parking lot construction. Glass that has been reduced to a fine aggregate size fraction (No. 4 sieve or less than 4.75 mm in size) exhibits properties similar to that of a fine aggregate or sandy material, with relative high stability, due to the angular nature of crushed glass particles. Blending with other conventional coarse materials will typically be required to meet required granular base gradation specifications for roadbeds. It has been recommended that maximum cullet content should be limited to 15 percent in granular base applications and 30 percent in sub-base applications. (Dames and Moore Inc., 1993)

Dames and Moore consulting engineers conducted extensive research in alternative uses for glass for CWC in 1993. The research project, titled “Glass Feedstock Evaluation Project”, resulted in a series of publications offering technical assistance and training information regarding glass recycling. One of the publications, a brochure titled “Using Recycled Glass as Construction Aggregate: A Summary of the Glass Feedstock Evaluation Project” states:

> “Both laboratory analysis and equipment evaluation point to the technical and economic viability of using (reclaimed glass) cullet as a construction aggregate feedstock. Cullet is strong, clean, safe, and economical. Its benefits from an engineering standpoint include permeability, good compaction characteristics, and compatibility with conventional construction equipment. Many states, countries, municipalities and private contractors, in fact, have already approved cullet for use as construction aggregate and are conducting field trials.”

Other related research has been conducted by private and government agencies. The findings of many of these studies have been summarized in a CWC publication entitled "A Tool Kit for the Use of Post-Consumer Glass as a Construction Aggregate."

Nova Scotia Transportation and Public Works (NSTPW) was contacted regarding the use of cullet in the construction of highways and roads. NSTPW personnel stated that the department has not investigated the use of crushed glass in road base; however, the department might further investigate this issue if a proposal was developed that was supported with proven research.

Dexter Construction indicated they might be interested in a pilot project if it was supported by NSTPW.

Potential Application for Nova Scotia: Yes

4.5 SPECIALTY ASPHALT

Asphalt containing glass cullet as an aggregate is called "glassphalt" and is similar to conventional hot-mix asphalt, except that a percentage of the rock and/or sand aggregate are replaced by crushed glass.

According to research conducted by CWC, most installations of glassphalt have been designed to meet the standards of The Asphalt Institute for medium traffic asphalt, which specify applications where the maximum speed limit is 40 mph. These standards include requirements for stability, flow, voids in mineral aggregate, percentage of air voids in the mix, and unit weight. The most common applications are as surface pavement for residential streets, secondary roads, parking lots, sidewalks, and curbing.

When glassphalt is placed and compacted, larger glass particles tend to align themselves parallel to the road surface. This can cause the skid resistance of glassphalt to be slightly lower than that of conventional asphalt. Consequently, glassphalt is not recommended for surface pavement on highways. However, the skid resistance of glassphalt containing less than 10% glass by weight with cullet particles smaller than ¼-inch in size shows no appreciable difference from asphalt containing 100% natural aggregate. CWC indicated that if the glass aggregate is used as part of the asphalt base below the surface pavement, then the size of the glass particles and the skid resistance of the material are not a concern (CWC, 1996. "Best Practices in Glass Recycling – Recycled Glass in Asphalt").

NSTPW was contacted regarding the use of crushed glass in the construction of asphalt for highways and roads. NSTPW personnel indicated that the department conducted a study of using glass in asphalt in the mid 1990's. The results of their study indicated that the glass tends to strip from the asphalt. The department is therefore not interested in using glass in asphalt or conducting additional studies.

Potential Application for Nova Scotia: No

4.6 DAILY LANDFILL COVER AND LANDFILL CONSTRUCTION

The NSEL Municipal Solid Waste Landfill guidelines require that cover be placed on fresh solid waste deposited in a landfill at least once per day or more often if required. Daily cover of waste controls odours, limits moisture infiltration from the surface, and minimizes leachate generation in the waste cell.

Glass can also be used as a sub-base material for roads through out a landfill. Broken glass is laid down with a top layer of gravel. This lowers the cost of the gravel roadways that allow vehicles and equipment entry into the landfill dumping areas of the refuse cells. The City of Winnipeg has implemented this use throughout their landfill.

Potential Application for Nova Scotia: Yes

4.7 GARDENS, LANDSCAPING, & WALKING TRAILS

Crushed mixed colour glass can be an attractive ground cover or garden mulch, if the glass cullet is properly processed to remove abrasive edges and contaminants. Processing to this quality may require a system that includes crushing, tumbling, cleaning, screening, and dust control.

Processed glass should be less than 1/4-inch or less in thickness to prevent the pieces from looking like broken bottles. In addition, larger pieces may not be adequately processed by a "tumbling" processor and are more likely to have sharp edges. Generally, 3/8-inch and finer glass should be used in landscape projects. Typically, there is a choice of three colours for landscape applications: clear, green, and amber. Clear glass reduced to particles 1/8-inch and smaller can look white. If only sizes 1/8-inch to 1/4-inch are used, the clear glass is more reflective and shimmers. Over time, the native soils may migrate into glass, making it necessary

to either renew the glass layer or turn the glass into the soil. (CWC, 1996. “Best Practices in Glass Recycling – Landscaping Applications for Recycled Glass”)

HRM presently uses a compost/sand mixture for their sport fields. According to personnel from Kynock Resources Ltd., approximately 2,500 m^3/yr of this mixture (which contains 30% sand) is used annually by HRM. HRM indicated that the municipality experienced difficulty marketing the compost/sand mixture for sport field applications due to public perception of pathogens, beetles, etc. in the compost. Presently, HRM do not anticipate that there would be an interest in using “glass sand” in the mixture due to anticipated public safety perceptions. However, a contact from HRM indicated that they may consider the “glass sand” option in the future.

The Municipality of the District of Lunenburg (MODL) were contacted regarding the potential use of processed glass on walking trails. MODL indicated they were possibly interested in a pilot project where glass was used either as a sub-base aggregate or sand cover.

The Second Lake Regional Park Association in HRM have also offered to host a demonstration pilot project for glass aggregate as part of their multi-year trail construction program.

Potential Application for Nova Scotia: Yes

4.8 REFLECTIVE BEADS FOR ROAD PAINT

Glass beads used in road paint reflect light and increase visibility, especially during darkness, rain, and fog. Only clear glass can be used to produce glass beads for reflective paint. There is no known reflective bead market opportunity for mixed or coloured glass.

NSTPW specifications for glass beads used in traffic paint indicate that more than 75% by mass of the glass beads must be true spheres, with specific gradation requirements ranging from 75 µm to 850 µm (NSTPW, 1992). The beads must be smooth, lustrous and free from film scratches and pits.

Processing post-consumer glass to this specification would require a large capital investment in processing equipment, as well as high equipment maintenance costs. This end use is not economically feasible for the Nova Scotia market.

Potential Application for Nova Scotia: No

4.9 FIBREGLASS INSULATION

Many fibreglass companies, such as Owens Corning, use post-consumer glass in their fibreglass insulation production process. The basic specification for processed crushed glass in the production process is 12 mesh with very low contamination and organic count (<1%). (Envirosis, 2001)

According to the "City of Toronto Glass Market Development Study", fibreglass insulation manufactured by Owens Corning displays an eco logo to signify the fibreglass contains 35% recycled content by net weight. In April 2001, Owens Corning was not using post-consumer glass because metal and ceramic contamination in the glass caused problems in the furnace and on the production line. The contamination blocked small chutes used to produce strings of fibreglass.

Vitreous Capital Inc. collects post-consumer glass recycled in Alberta and British Columbia. The company crushes 90,000 tonnes/yr of post-consumer glass and ships the crushed glass to the fibreglass industry, predominantly Owens Corning.

There are no major fibreglass insulation producers in Nova Scotia, therefore, local opportunities for the use of processed crushed glass does not exist.

Potential Application for Nova Scotia: No

4.10 WINTER SAND/SALT MIX FOR ROADS

Sand is often added to road salt to improve traction for vehicular and pedestrian traffic. Sand is also used in winter instead of salt in rural areas where residential water wells exist and when temperatures are too cold for salt alone to be effective.

In San Juan County, Washington, processed glass was used in a winter sand mix, but residents complained about the glare created by the headlights of oncoming cars.

Based on discussion with NSTPW personnel, the use of glass sand in winter sand/salt mix has not been investigated. The primary concern of NSTPW is the potential damage of tires from the glass material. The department indicated they may entertain the potential use in "glass sand" if a proposal with proven research was submitted.

Potential Application for Nova Scotia: Yes

4.11 CONTAINER MANUFACTURING

Silica sand, soda ash, and limestone are the primary raw ingredients for the production of glass containers. Manufacturing of new glass containers requires the cullet to be free of contaminants such as ceramics and metals, since the processing temperature does not melt many of the contaminants in the cullet. These contaminants can damage the glass melting furnace and cause problems with quality of glass containers being produced. Colour sorting of cullet is an important component of container manufacturing. This is done to prevent an undesirable tint to the glass containers.

Owens Illinois in Scoudouc, NB manufactures container bottles. Their process requires the cullet feedstock to be ½ minus, well sorted by colour, and free of contaminants.

Potential Application for Nova Scotia: Yes

4.12 SUMMARY OF EMERGING MARKETS

The investigation of emerging glass markets indicates that there are many alternative end uses for glass that may be applicable to local markets in Nova Scotia. These markets include:

- Container manufacturing;
- Sandblasting material;
- Roadbed aggregate;
- Daily Landfill Cover and Landfill Construction;
- Walking trails;
- Wastewater filtration in septic beds; and
- Winter sand /salt mix for roads.

Processing requirements for these options are discussed in further detail in Section 5.

5. PROCESSING REQUIREMENTS

5.1 OVERVIEW

Glass processing can be accomplished manually, mechanically, or by a combination of both. The size of the processed glass (sand or cullet sizes), the level of contaminant removal, and the final specifications of the end product determine the types of equipment required. The simplest form of processing involves crushing the glass and removing some of the contaminants. On the other end of the spectrum is processing that requires crushing/grinding to a specific mesh size with a very low tolerance level for contaminants. This type of processing requires specialized equipment or human resources to sort and remove unwanted materials, clean the glass and crush to the required size.

A common concern from regions processing glass is the high maintenance cost associated with glass crushers due to the abrasive nature of glass. In addition, glass crushing requires specialized ventilation equipment to ensure that workers are not exposed to harmful particulates during the crushing operation.

5.2 CONTAMINATION OF GLASS FEEDSTOCK

Many emerging markets are accepting post-consumer glass as a feedstock. Although the specifications of the cullet vary, the markets generally require the feedstock to contain low levels of contaminants, such as metals, organics, and ceramics.

Ceramic contamination is a broad category including materials such as dishware, porcelain caps, pottery, heat resistant cookware (Pyrex™, Visionware™), mirror glass, and light bulbs. Ceramics can be removed from the glass feedstock manually or with automated systems.

Metal contaminants, ferrous or non-ferrous, are generally in the form of container lids or seals. Ferrous metals include iron and steel and can be removed through magnetic separation techniques. Non-ferrous metals, such as brass, aluminum, lead, and stainless steel must be removed with non-ferrous electrical detection or manually.

Organic contamination includes paper and plastic labels and caps, paper and plastic bags, wood debris, corks, plants, food residue, and any other material composed of carbon. Organic material can be removed by washing, passing the cullet through a size-specific screening device, or by incineration.

Metal and organic contaminants are less friable than glass; therefore, they do not fracture as easily in glass crushers and can be removed through screening.

5.3 TYPICAL GLASS PROCESSING SYSTEMS

The selection of waste glass processing equipment is dependant on the amount of contamination present in the glass feedstock and the level of contaminant removal required for the end product. Material recovery rate is affected by the manner in which containers are collected, transported, sorted, and handled since broken glass is more difficult to sort than unbroken glass. A summary of typical processing systems required for the potential opportunities in local markets is presented in Table 5-1. The potential markets have been sorted, with the market requiring the least amount of processing at the top and the most process intensive market at the bottom of the table.

Table 5-1: Summary of Processing Requirements for Potential Markets in Nova Scotia

Potential Market	Local Opportunity	Market Specifications	Typical Equipment Required	Cost
Roadbed aggregate	• NSDOT roads • Lunenburg trails • HRM trails	Cullet with some contaminant removal	Glass crusher, conveyors for manual sort, screens	Low
Daily Landfill Cover and Landfill Construction	• Municipal landfills			
Wastewater filtration in septic beds	• NSEL	Glass sand with some contaminant removal	Glass pulverizer, conveyors for manual sort, screens	Low to medium
Sandblasting material	• Shaw Resources • Lunenburg Foundry	Cullet/glass sand with high level of contaminant removal	Glass crusher/pulverizer, conveyors for manual sort, screens, magnet, eddy current separator	Medium to High
Winter sand / salt mix for roads	• NSDOT roads	Glass sand with high level of contaminant removal	Glass pulverizer, conveyors for manual sort, screens, magnet, eddy current separator	Medium to High
Walking trails	• Lunenburg Trails • HRM Trails			

Potential Market	Local Opportunity	Market Specifications	Typical Equipment Required	Cost
Container manufacturing	• Owens Illinois	Cullet with high level of contaminant removal	Glass crusher, conveyors for manual sort, screens, magnet, eddy current separator. Specialized colour separation equipment and specialized ceramic/metal removal may be required due to stringent specifications.	High

Roadbed aggregate, daily landfill cover and landfill construction

Most sub-base markets, such as roads and trails, usually require a minimum of manual removal of oversized contaminants. The production of this type of aggregate material is the cheapest of the processing options investigated, but limits the number of end markets that will accept the product.

Wastewater filtration in septic beds

NSEL is reviewing their specifications regarding imported sand for on-site sewage disposal systems and are considering the use of glass sand. NSEL must determine if the glass sand will have sufficient permeability for application in disposal fields. If the material is accepted, it will not likely require extensive contaminant removal; however, the levels of accepted contaminants would be investigated before a specification would be developed.

Sandblasting material, Winter sand / salt mix for roads, Walking trails

For use in the sandblasting industry, contaminants must be removed from the glass sand. Shaw Resources may be interested in accepting crushed glass if it was clean and between ¼" minus and ½" minus since they can further process this cullet in their silica mill. Winter sand/salt mix and sand for trails would require a similar level of contaminant.

Container manufacturing

Based on discussion with Andela, manufacturer of glass processing equipment, specialized equipment is usually required to produce a feedstock acceptable for use in manufacturing glass containers. Andela indicated that a preliminary design and costing for a processing system could not be determined unless the level of contaminants in the glass to be processed and the specifications of the end product are known. Specialized equipment is often required for colour sorting and removal of ceramics and metals. Andela estimated that the cost for a glass processing plant that will sort one colour of glass to be used for container manufacturing would be between 1 to 2 million dollars (US).

SLI contacted some of the facilities that have processed post-consumer glass for use in some of the markets discussed. The majority of the responses indicated that processing glass is an expensive venture and is not profitable. One exception was Vitreous Capital Inc., located in Alberta. The results are summarized in Table 5-2.

Table 5-2: Summary of Processing Experience in North America

Location	Industry / Use	Findings
San Juan County, WA	Septic / road sub-base/ road salt	Operations cancelled because pulverizer to expensive to operate. Residents complained of glare from road salt
Schenectady County, NY	Landfill cover / Road sub-base and cover	Pulverizer expensive to maintain and conveyor had problems. Problems likely caused from equipment being set up outside Found glass to be excellent material for dust suppression. Less expensive than water.
Vitreous Capital Inc., Alberta	Fibreglass	Largest expense is crusher maintenance, send largest is trucking. Vitreous states that glass processing is profitable for them.
Encorp in Vancouver, British Columbia	Non-profit stewardship Corporation; ship most of their glass to Vitreous Capital Inc. (Fibreglass)	Encorp pays for industries to take their glass. Looked into setting up MRF, but found it was not cost effective. Cheaper to buy sand than to process glass.
Yarmouth, NS	Container Glass Manufacturing	H&H Recovery Ltd. sorts post-consumer glass manually and markets this glass to Owens Illinois in Scoudouc, NB. H&H personnel stated that their glass operation is not profitable.

Extensive manual sorting will also produce a glass feedstock that meets the requirements of the container manufacturing industry. H&H Recovery Ltd., located in Yarmouth, NS, colour separate the glass and remove contaminants manually, without the aid of any mechanized equipment. After the sorting is completed, the clean cullet is sent through a crusher and shipped to Owens Illinois, who have stated that the feedstock from H&H Recovery is one of the best quality feedstock they receive. H&H Recovery Ltd. indicated that their glass operation is not profitable since it is very labour intensive.

RRFB indicated that the deposit bottles recycled at Enviro-Depots in NS have few contaminants after they are manually sorted at each depot and minimal processing is required to achieve the glass cullet specifications required by Owens Illinois. Equipment that would be required includes conveyors (so that contaminants remaining on glass can be removed manually), a crusher, and multiple screens.

6. HEALTH AND SAFETY CONCERNS

The most common health concern regarding the use of cullet aggregates is the potential for skin cuts or abrasions. According to CWC, experience has shown that cullet 3/4 inch or smaller presents no greater cut or penetration hazard than fractured natural aggregates such as crushed rock. Therefore, the same safety precautions for working with natural aggregates should also be followed when working with cullet. (CWC, 1996. “Safety Measures for Cullet Aggregate at Construction Sites”.)

CWC research has indicated that exposure to glass dust is another potential health concern with cullet aggregate. Studies have been conducted to determine whether glass dust contains crystalline silica, a known carcinogen. These studies have found that glass aggregate dust typically contains less than 1% crystalline silica by weight and is not considered hazardous by federal standards. This places cullet in the category of “nuisance dust” with a Permissible Exposure Limit (PEL) of 10 mg/m^3. Glass cullet dust can be a skin and eye irritant. Cullet dust is abrasive due to the high angularity of its particle shapes and appears to be more irritating than dust from natural aggregates or soils. However, experience from construction sites indicates that cullet dust, and the irritations associated with the dust, can be easily prevented using simple measures that include applying water to the glass sand before dumping and wearing appropriate personal protective equipment when handling glass sand. (CWC, 1996. “Glass Aggregate Dust Control at Construction Sites”)

7. CONCLUSIONS

Although there are difficulties regarding the recycling of post-consumer glass into container glass, there are opportunities in alternative markets. Some observations follow.

7.1 THERE ARE OPPORTUNITIES WHICH SHOULD BE PURSUED

Local organizations offer the following opportunities:

- Owens Illinois (Container Manufacturer) and Shaw Resources (Sandblasting) are interested in purchasing cullet if contaminants are removed. Shaw Resources does not have a detailed specification for glass, but may be interested in conducting a pilot project. Shaw has the capability of taking more than 66% of the post-consumer glass collected in Nova Scotia.
- NSEL are presently investigating the use of glass sand in on-site sewage disposal systems. A pilot project could be a step towards a viable use for post-consumer glass.
- NSDOT may consider pilot projects for use of glass in sub-base aggregate and for use of glass sand in winter sand/salt mix if proposals with proven research were presented.
- MODL is interested in conducting a pilot study for walking trails in Lunenburg and HRM at Second Lake;
- Lunenburg Foundry may be interested in a pilot project for glass sand to be used in sandblasting.

7.2 PROCESSING GLASS TO MEET SPECIFICATIONS CAN BE DIFFICULT AND EXPENSIVE

Processing costs vary based on the size of cullet or sand required and the level of contamination that has to be removed. There is no unique specification for each market and requirements within each market also vary based on the organization purchasing the glass.

A common concern from regions processing glass is the high maintenance costs associated with glass crushers due to the abrasive nature of glass. In addition, glass crushing requires a specialized ventilation system to address this condition.

Extensive manual sorting can be as effective for removing contaminants as specialized mechanical equipment. Due to the quantities of glass available in Nova Scotia, specialized mechanical equipment for contaminant removal is not expected to be cost effective. However recognizing that the glass from deposit-return containers collected through the Enviro-Depot system has been well-sorted manually and is relatively free of contaminants, SLI recommends that a pilot study be conducted with that glass to determine more precise requirements. Related costing could then be developed to determine if this venture is financially feasible based on the available feedstock in the province.

7.3 GOVERNMENT CAN TRY TO CREATE ITS OWN MARKETS

There is a need for cooperation between government departments at both the municipal and provincial levels. For instance, Nova Scotia Environment and Labour has banned glass from disposal in Nova Scotia landfills, so it is a material that must be recovered and re-used or recycled. At the same time, there is potential for post-consumer glass to be used in the provincial road system. This is an opportunity to close the loop on recycling glass by processing it and using it as road sub-bases, replacing aggregate that has an environmental consequence when it is mined. In fact, if satisfied with the performance, NSDOT could change their specifications to require that the sub-base of their roads contain as much as 30% recycled glass, which would likely result in all of Nova Scotia's glass being used each year. Yet to date, the NSDOT has not tried using glass as a sub-base.

Similarly, municipalities could be using glass in their parks, in trails and decorative landscaping. However, the Parks Departments do not do so, even though their colleagues in the solid waste departments have difficulty finding affordable markets for their glass. Municipalities would be well advised to look within their own departments to see where glass might be used, such as in parks and local road construction.

It is recommended that an interdepartmental task force be established to develop and implement a plan for provincial and municipal governments to close the loop on recycling by creating their own market for the material, and reducing the reliance on a single glass container manufacturer that requires the most expensive specification.

7.4 HEALTH AND SAFETY ISSUES ARE IMPORTANT AND MANAGEABLE

Many local authorities are concerned regarding health and safety issues associated with the use of glass sand. The most common response for not considering glass use in sand markets was the anticipated negative public perception that is expected if glass was to be used as surface cover in recreational locations such as sport fields and parks, and potential damage to tires from winter sand/salt mix. According to the glass feedstock evaluation project conducted by CWC, proper processing can produce ¾ inch cullet that presents no greater cut or penetration hazard than fractured natural aggregates such as crushed rock.

Better record keeping is required to more accurately track the quantities and flow of glass in Nova Scotia. Awareness from government agencies is required to recognize the problems that exist in marketing glass, funding research, and developing pilot studies to investigate the feasibility of potential local glass markets, and educate the public regarding the misconceptions of glass recycling.

8. PRELIMINARY COST ESTIMATE FOR LOCAL GLASS HANDLING FACILITY

SLI has developed preliminary cost estimate for the design and operation of a glass receiving and crushing facility to process the post-consumer glass recycled in Nova Scotia. It should be noted that the cost estimate is based on a specialized processing system capable of sorting glass by colour and removing contaminants to levels that meet the container manufacturing market, which has the most stringent specifications for a glass feedstock. It is possible that the specialized processing equipment would not be required if the MRF operation was developed utilizing extensive manual sorting, similar to the H&H Recovery Ltd. operation in Yarmouth. However, this type of operation would require an increase in staffing.

The capital cost estimate is presented in Table 8-1 and annual operational/maintenance costs are presented in Table 8-2.

Table 8-1: Capital Cost Estimate for Post-Consumer Glass Handling Facility

Item	Cost ($)
Land Purchase	--
Site Preparation - Site grading, excavation, clearing, grubbing, etc. Assumptions: • size of site: 150m x 150m; • 0.25 m of excavation and backfill for the site at $10/m.	$56,250
Access Road	--
Onsite Paving Assumptions: • 1000 m^2 of the site would require paving, at a cost of $20/$m^2$	$20,000
Glass Handling Building - To accommodate a tipping floor, two loading bays, and loader operations it was assumed the building would have to be approximately 1000m^2. The unit cost of the metal pre-fabricated building with radiant heating and ventilation system, including concrete floor is estimated to be $750/$m^2$.	$750,000
Office - includes septic and water	$50,000
Weigh Scale	$250,000
Power Supply - Extend Power Supply @ $25/m	--
Processing Equipment - Based on information from Andela for specialized system to process glass to specifications typically required for container manufacturing.	$1,800,000
Loader	$150,000
Fencing and Gates - 3m fence around perimeter of site (approx. 600m) at $55/m. Assumptions: • $2000 for gates;	$35,300

Item	Cost ($)
• $300 for signage.	
Landscaping	$10,000
Sub-Total	$3,121,550
Contingency (10%)	$312,155
Engineering (15%)	$515,056
TOTAL	$3,948,761

Table 8-2: Annual Operational/Maintenance Cost Estimate for Post-Consumer Glass Handling Facility

ITEM	COST ($/year)
Staffing - Four permanent employees @ $15/hour + 35% payroll burden	$168,480
Maintenance (@ $5/tonne) - based on 12,000 tonnes/yr	$60,000
Loader Operation - 5 hr/day @ 5 days/week@ 52 weeks/year@$40/hr	$52,000
Transportation to Scoudouc, NB	--
Snow Clearing	$10,000
Power Lighting, misc	$1,500
TOTAL	$291,980

9. REFERENCES

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NSTPW (1992). “Material Specifications for Glass Overlay-Type Beads”.

APPENDIX A

Verbal Contact Reports

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB	**DATE**	January 10, 2006
ORGANIZATION		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL (SNC♦Lavalin)	**CONTACT TYPE:**	
And	Doug Vickers	☒ **Telephone** ☐ **Meeting** ☐ **Other:** 452-3917	
COPY TO	file	**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Doug Vickers from Perrac regarding unit-hauling costs for recycled glass. Doug indicated that tonnage is not a major consideration for bidding and unit costs for long distance hauling are bid in $/mile. This rate assumes that specialized equipment is not required. Doug believes that a 53 ft open container truck would be sufficient and specialized equipment should not be necessary. In addition, a fuel surcharge (as specified by the Atlantic Provinces Trucking Association) would be added to the hauling cost. This surcharge is presently approx. 25% of the cost of hauling.

Doug indicated that it would be advantageous if the glass were crushed since more glass would be transported per load for the same price. He estimates from experience that seven times more glass would fit on the truck if it were crushed. He said that Nova Scotia Department of Transportation (NSDOT) sets a load capacity for trucks based on the number of axles and thinks the upper limit may be 60, 000 lbs, but suggests calling NSDOT for confirmation.

Doug also mentioned that he would be interested in bidding on the hauling of recycled glass.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB	**DATE**	February 9, 2006
ORGANIZATION		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL (SNC♦Lavalin)	**CONTACT TYPE:**	
and	Robert Anderson, NSEL	☒ **Telephone** ☐ **Meeting** ☐ **Other:** 424-2580	
COPY TO	file	**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Robert regarding glass recycling in NS. Robert indicated that NSEL, Dalhousie, & Enviroglass Ltd. did a study of using glass for wastewater treatment. They processed blue bag glass to different sand sizes and conducted sieve and permeability analysis on the sand. They did not investigate the performance of the crusher and did not pilot test the sand that was produced. However, Robert did say that NSEL would be interested in running a pilot study for septic beds or wastewater filters and mentioned that the Agricultural College in Truro had facilities that could be used to run such a pilot test.

Robert believes that there may be approximately 12,000 tonnes of commercial glass waste available in Nova Scotia. Using glass waste from companies such as Kohler Glass and Atlantic Glass would be beneficial since the glass is much cleaner than food containers, bottles, etc.

Robert also mentioned that Enviroglass Ltd. used to process glass and send their material to Shaw Resources in Shubenacadie. They would wash, screen, and store the processed glass in tote bins and sell as a blasting abrasive. He thought that they were selling the material for between $100-$140/tonne. Therefore, he thought that there would be a limited market for wastewater treatment.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 9, 2006
ORGANIZATION	Municipality of Lunenburg		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Pierre Breau		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 541-1331	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Pierre regarding the project that he conducted with Dr. Graham Gagnon from Dalhousie University. Pierre indicated that one of Graham's graduate students did field testing of glass media for a recirculating filter. Both clear and coloured glass were obtained from the MRF in Lunenburg. The student attempted to chip both clear and coloured glass to pea-sized gravel with an industrial strength grinder. The chipped glass (1-3mm diameter) was mixed with pea gravel and used in a recirculating wastewater filter. The results of the test indicated a similar removal rate of BOD and TSS as compared to a filter with only pea gravel media. Although the void space was greater in the glass media filter, it was suspected that the additional surface area of the glass allowed for more bacteria to treat the wastewater.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 8, 2006
ORGANIZATION	Encorp Pacific		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Mike		☒ **Telephone** ☐ **Meeting** ☐ **Other:**	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to an employee of Encorp regarding the beverage recycling program in British Columbia. Encorp is a federally incorporated not-for-profit stewardship corporation. Mike told me that Encorp does not process glass; they only sub-contract the transportation. The majority of their glass is shipped to Vitreous in Calgary and is used in the fibreglass industry. Other end uses for recycled glass in BC include sandblasting and backfill for piping. Mike indicated that Encorp pays a fee for industries to take their glass.

Encorp looked into buying a pulverizer and processing glass before shipping it. They discovered that it was not cost effective due to the expensive maintenance costs. He stated that purchasing sand is cheaper than processing glass into sand.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 16, 2006
ORGANIZATION	Vitreous		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Pat Cashin		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 403-616-2773	
COPY TO	file			
			PROJECT No.	017075

COMMUNICATION DETAILS:

I spoke to Pat Cashin regarding glass recycling in Alberta and BC. He told me that Vitreous crushes 90,000 tonne of glass per year with a CEMCO crusher and ships the crushed glass to the fibreglass industry, predominantly Owens Corning. He stated that the largest operating cost is maintenance for the crusher (approx. $3/tonne). The second largest expense is trucking, which they pass on to the buyer. Pat indicated that glass processing is a profitable undertaking in Alberta.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 14, 2006
ORGANIZATION	Schenectady County, NY		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Jeff Edwards		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 518-386-2225	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Jeff regarding glass processing. Jeff stated that the county is no longer involved in glass processing. They had problems with the pulverizer, it was expensive to maintain and the conveyor had problems. Jeff thought that some of the problems were likely caused from the equipment being set-up outside and being exposed to the elements.

The county used to use the processed glass for landfill daily cover and sub-base/cover material for roads. He stated that glass is excellent for dust suppression.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 16, 2006
ORGANIZATION	San Juan County, WA		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Ed Hail		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 360-370-0500	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Ed regarding glass processing. Ed stated that they used to crush glass, but they took their pulverizer off-line because it was too expensive to operate based on the tonnage they were recycling.

The county used to use the processed glass for septic fields and road fill. The state changed the spec for these uses and the processed glass didn't meet this standard. Also, San Juan County is a series of islands serviced by ferry, so transportation costs did not make it cost effective to ship the glass to other industries on the main land.

The processed glass was later used as road salt, but residents complained about the glare picked up by the headlights of the cars.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 21, 2006
ORGANIZATION	HRM		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	(SNC♦Lavalin)	**CONTACT TYPE:**	
and	Fred Wendt, HRM		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 490-7175	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Fred, a Waste Resource Analyst with HRM Solid Waste Resources, regarding glass recycling in HRM. Fred stated that HRM's glass is hauled to Neighborhood Recycling in Scoudouc, NB. A small business (Amherst Glass) used to take some of their glass to produce decorative glass. Fred said the quantity used at Amherst Glass was negligible.

During the 2004/2005 fiscal year, 224 tonnes of glass was sent to Neighborhood Recycling from the HRM MRF at a cost of approximately $116/tonne.

Fred indicated that HRM would be interested in utilizing waste ceramics and porcelain in addition to the glass. Enviroglass, which is now out of business, used to collect porcelain and ceramic from HRM and used it to produce sandblasting material.

Fred indicated that HRM's compost from New Era Farms is purchased by Kynock Resources. They make a sand/compost mixture that is currently used on HRM sport fields. Miller also produces a topsoil mix that they market. He suggested contacting these companies to see if they may be interested in substituting pulverized glass for sand.

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 23, 2006
ORGANIZATION	Kynock Resources Ltd.		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Pierre		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 835-2446	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Pierre from Kynock Resources Ltd. stated that his company used to market a compost/sand mixture for HRM sport fields. His company no longer has the contract for this service.

Pierre indicated that approx. 2500 m^3/yr of mixture with 30% sand is used on the sports fields in HRM. He did not have the spec for the material, but suggested I contact Peter Verge from HRM.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 23, 2006
ORGANIZATION	HRM		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Peter Verge		☒ **Telephone** ☐ **Meeting**	
COPY TO	file		☐ **Other:** 476-4160	
			PROJECT No.	017075

COMMUNICATION DETAILS:

Peter stated that HRM recently had a hard time marketing the compost/sand mixture for the sport field due to public perception of pathogens, beetles, etc. in this material. Presently, he didn't think that there would be an interest in using "glass sand" in the mixture due to potential safety perceptions from the public and the fact that HRM staff had such a hard time getting the sand/compost mixture approved. However, he indicated that HRM may be open to considering the "glass sand" option in the future.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 23, 2006
ORGANIZATION	Miller Compost		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Peter Verge		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 468-3161	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Miller produces a compost/sand mix for lawns and gardens. Martin indicated that Miller would not likely be interested in using “glass sand” since it does not have any micronutrient value and may create negative public perception about the compost product.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 23, 2006
ORGANIZATION	Shaw Resources		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Gordon Dickie		☒ **Telephone** ☐ **Meeting**	
COPY TO	file		☐ **Other:** 499-9343	
			PROJECT No.	017075

COMMUNICATION DETAILS:

Gordon stated that they tried to market glass supplied by Enviroglass Ltd. and the project did not work well. Enviroglass stated that they could supply 10,000 tonnes of crushed glass, however, they only processed 300 tonnes before the company went bankrupt. The glass was going to be further processed by Shaw in Shubenacadie and marketed as sandblasting material for the autobody trade. The autobody trade needs sandblasting mesh sizes of 20-40 and 30-60. According to Gordon, the material that Enviroglass delivered was dirty and the grain size was not sufficient for their use.

Gordon stated that he would still be interested in accepting crushed glass if it was clean and between ¼" minus and ½" minus. Shaw would further process this cullet in their silica mill, then dry and screen it.

It is likely that Shaw would not pay for receiving this glass since they would need to further process it, but they would possibly be willing to look at their processing costs to determine if this was the case.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 23, 2006
ORGANIZATION	NSDOT		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Tom Gouthro		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 860-5600	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Tom is the Manager of Technical Services for NSDOT. He indicated that they have been approached in the past to use glass as an aggregate material and it has not been well received based on literature research. Tom indicated it tends to strip from asphalt.

As far as he knows, NSDOT has not investigated the use of crushed glass in road base and does not think that NSDOT would be interested in using glass in the near future.

He recommended calling Gerald Lee (NSDOT) to discuss further.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 24, 2006
ORGANIZATION	Colchester MRF		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Tom MacMillan		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 860-5600	
COPY TO	file			
			PROJECT No.	017075

COMMUNICATION DETAILS:

Tom indicated that Neighborbood Recycling is paying approx. $68/tonne for glass to be delivered to their facility and crushed to 5/8" size.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 24, 2006
ORGANIZATION	Lunenburg MRF		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	(SNC♦Lavalin)	**CONTACT TYPE:**	
and	Teri Swift		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 543-2991	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Teri indicated that Lunenburg MRF is shipping the RRFB blue bins to Neighborhood Recycling in Scoudouc, NB. The glass is considered to be owned by RRFB and they pay a nominal fee for each tub. Neighborhood Recycling sends trucks to pick up the glass and takes the glass at no expense. They do not pay Lunenburg for the glass.

Starting April 1, 2006, Lunenburg plans on taking ownership of the glass and storing it in two outside bunkers at their facility. They plan to load glass onto dump trailers and haul it to Scoudouc themselves. At this time, they will be able to negotiate a price for selling their glass.

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 24, 2006
ORGANIZATION	The Bin Doctor		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Robert Loppie		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 830-4214	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Robert indicated that the Bin Doctor is shipping RRFB blue tubs filled with glass to Neighborhood Recycling in Scoudouc, NB. The glass is considered to be owned by RRFB and RRFB pays $2.75 for each tub shipped to NB. Neighborhood Recycling sends trucks to pick up the glass and takes the glass at no expense. They do not pay the Bin Doctor for the glass.

The Bin Doctor ships approximately 55% of the province's glass. The glass is received from MRFs in the HRM region. RRFB pays for transportation costs from the Enviro-Depots to the Bin Doctor Facility in Burnside. The Bin Doctor ships two truckloads/day in the summer and one truckload/day during the other months. Each truckload contains 60 RRFB blue tubs. Robert is going to look for the specs of the tubs and get back to me regarding volume and weight when the tubs are full with uncrushed glass.

Robert stated that Neighborhood Recycling in NB processes approx. 65,000 tonnes of glass per year (since he gets the glass from many sources, NS being just one). They sell their processed glass to Owens Illinois in Scoudouc, NB for between $80-$90/tonne. Owens Illinois produces beverage container glass from cullet. The Bin Doctor is interested in processing glass and selling directly to Owens Illinois, but only if processing glass in Burnside was profitable.

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 24, 2006
ORGANIZATION	Dexter Construction		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	(SNC♦Lavalin)	**CONTACT TYPE:**	
and	Ian Noseworthy		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 835-3381	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke with Ian regarding using crushed glass in road salt, and sub-base for roads, parking lots, etc. He was not aware of this use and indicated he would ask around to see if there would be any interest.

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 28, 2006
ORGANIZATION	Owens Illinois		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Oscar Robichaud		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 506-532-7200	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke with Oscar regarding glass cullet used for processing bottles at Owens Illinois in Scoudouc, NB. He stated that the glass cullet has to be ½" minus with no impurities. It has to be clean and well sorted according to colour (clear and green). The average plant that processes glass to these specs costs more than 1 million dollars. Oscar did not provide any information regarding equipment required to process glass to this spec.

SNC·LAVALIN

VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	February 24, 2006
ORGANIZATION	NSDOT		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Gerard Lee		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 424-5582	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Gerard stated that NSDOT conducted a study 10-12 years ago that investigated the use of glass in asphalt. The results concluded that the glass tended to strip from the asphalt.

As far as he knows, NSDOT has not investigated the use of crushed glass in road base. They might entertain the potential use in sub-base if someone presented a proposal with proven research.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	March 13, 2006
ORGANIZATION	Dura-Tech		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Lee Johnson		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 462-8265	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

Lee indicated that Dura-Tech is not interested in glass cullet. They are a fibreglass company that purchases extruded material that is ready for use in their guns.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	March 13, 2006
ORGANIZATION	NSDOT		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Bruce Fisner		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 424-2297	
COPY TO	file		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I discussed the use of "glass sand" in winter sand/salt mix. Bruce indicated that NSDOT uses sand mixed with 5% salt in areas with water wells. As far as he knows, NSDOT has not investigated the use of "glass sand" in winter sand/salt mix. His main concern is the damage of tires from the glass. They might entertain the potential use in "glass sand" if someone presented a proposal with proven research.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	March 15, 2006
ORGANIZATION	Andela		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	David Hula		☒ **Telephone** ☐ **Meeting**	
COPY TO	file		☐ **Other:** 315-858-0055	
			PROJECT No.	017075

COMMUNICATION DETAILS:

I spoke with David regarding equipment required for glass processing and levels of processing. He recommended processing glass for markets that use aggregate since the processing required is less expensive and requires less contaminant removal. Processing glass for sale to container manufacturers is a detailed and expensive process. He indicated that setting up a processing plant for markets requiring low levels of contaminants (such as glass container manufacturing) is not profitable based on our limited quantity of recycled glass in Nova Scotia.

David indicated that a detailed spec that outlines the final size of the processed glass and the % of contaminants that can remain in the glass is required to carry out a preliminary design and cost the process. Unless he has a good spec, he will not know the types of equipment required to remove contaminants. He would also need to have a breakdown of the feedstock material that includes the percentages of each colour of glass in addition to the overall tonnage.

As an example of the cost involved, a specialized machine costing approx. $250,000 will be required if ceramic levels have to be below 1% (which is common in many container manufacturing and fibreglass processes) and another specialized machine will also have to be added if metals levels must be below 3%. Optical sorting equipment (approx. $500, 000) is required to achieve the spec usually required to market glass to container manufacturers.

David indicated that he can't even give us an equipment list or ballpark prices unless he designed the MRF based on a detailed spec. He estimated that it would cost between 1 to 2 million dollars (US) for equipment that will sort one colour of glass to be used for container manufacturing. This price does not include the cost for a building. The overflow from such a plant would be approx. 50% so other markets would be required for this overflow.

Since Andela would have to design the MRF to give us an equipment list and preliminary costing, David says he can't provide any additional information unless we hire his company.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	March 20, 2006
ORGANIZATION	Lunenburg Foundry		**PAGE**	1
CONVERSATION between	Chris Roach, SNCL	(SNC♦Lavalin)	**CONTACT TYPE:**	
and	Kevin Feindel		☒ **Telephone** ☐ **Meeting**	
COPY TO	file		☐ **Other:** 1-877-259-5433	
			PROJECT No.	017075

COMMUNICATION DETAILS:

Kevin indicated that Lunenburg Foundry presently uses copper slag for sandblasting media. They would be open to using glass sand if it was shown to have good cutting qualities. Lunenburg Foundries may be interested in a pilot study. Kevin did not know of the technical details that glass would have to be processed to meet. He is going to ask around and get someone to call me in the next few days.

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VERBAL CONTACT REPORT

PROJECT	Glass Study for RRFB		**DATE**	March 28, 2006
ORGANIZATION	Dillon Consulting Ltd.		**PAGE**	**1**
CONVERSATION between	Chris Roach, SNCL	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Chris Shortall		☒ **Telephone** ☐ **Meeting** ☐ **Other:** 450-4000	
COPY TO	file			
			PROJECT No.	017075

COMMUNICATION DETAILS:

Chris designs MRFs for Dillon Consulting Ltd. He indicated that a standard building they use for MRFs includes a 9m steel portion with 3m high concrete push walls. He indicated that a less robust structure could be used for glass but the height of the structure would depend on how the trucks would unload the glass. An elaborate ventilation system will be required for a glass recycling facility.

The unit cost of the standard Dillon MRF building is $\$900/m^2$ and includes steel, concrete, electrical, and mechanical components. He believed that the cost for a glass MRF would be between the cost of a warehouse and the $\$900/m^2$ MRF. He indicated that $\$750/m^2$ would be a reasonable assumption and suggested that we could call Rideau or Lindseys for the cost of a warehouse.

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VERBAL CONTACT REPORT

PROJECT	Glass Study	**DATE**	May 9, 2006
ORGANIZATION	Mun. of the District of Lunenburg	**PAGE**	1
CONVERSATION between	Chris Roach, SNCL (SNC♦Lavalin)	**CONTACT TYPE:**	
and	Laura Barkhouse	☒ **Telephone** ☐ **Meeting** ☐ **Other:** 541-1352	
COPY TO	file	**PROJECT No.**	017075

COMMUNICATION DETAILS:

Laura is the Trail Co-ordinator for Lunenburg. She indicated Lunenburg is possibly interested in a pilot project for use of glass as either a sub-base aggregate or sand cover. She is interested in obtaining information on glass use for walking trails.

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VERBAL CONTACT REPORT

PROJECT	Glass Study	**DATE**	February 22, 2006
ORGANIZATION	Halifax Regional Water Commission	**PAGE**	**1**
CONVERSATION between	Kathy Lea **(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Reid Campbell	☒ **Telephone** ☐ **Meeting** ☐ **Other:** (902) 490-4877	
COPY TO		**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Reid regarding the possibility of using glass in the municipal potable water treatment process, specifically to replace sand filters. Reid stated that sand filters are not replaced very often, perhaps just topped up. The sand media can be used for 50 plus years.

The water treatment facilities that are being built today do not include sand filter traps; design of water treatment has been focussed on membrane filtration and the industry is moving away from filter media. He was not aware of any new facilities being built that include sand filters.

In addition, any media that would be used for potable water supply would have to undergo a certification process before it could be utilized in the design.

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VERBAL CONTACT REPORT

PROJECT	Glass Study		**DATE**	July 28, 2006
ORGANIZATION	H&H Recovery Ltd.		**PAGE**	**1**
CONVERSATION between	Chris Roach	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	David Harris		☒ **Telephone** ☐ **Meeting** ☐ **Other:** (902) 742-3490	
COPY TO			**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to David regarding glass recycling in Yarmouth, NS. H&H Recovery Ltd. operate a municipal MRF in Yarmouth. He indicated they sort, process, and ship their clear glass directly to a market in New Brunswick, they do not ship to Neighborhood Recycling. He wasn't sure which market it was since he is not involved with the shipping.

Their processing consists of a manual sort typically with 13-14 sorters (who sort all of the waste received at the MRF) that separate the glass according to colour and remove contaminants. The glass is then crushed with a double drum system designed by David, based on a rock crusher. David indicated that he believes that H&H Recovery are the only recycler in NS producing glass clean enough to market without getting it further prcoessed by Neighborhood Recycling in New Brunswick. He mentioned that the buyer once found a piece of green glass the size of his thumb in the glass feedstock and would not accept this load. He indicated that they lose a lot of money on glass and are funded by the Municipality.

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VERBAL CONTACT REPORT

PROJECT	Glass Study		**DATE**	July 28, 2006
ORGANIZATION	Cumberland MRF		**PAGE**	**1**
CONVERSATION between	Chris Roach	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Dave Scott		☒ **Telephone** ☐ **Meeting** ☐ **Other:** (902) 667-5141	
COPY TO			**PROJECT No.**	017075

COMMUNICATION DETAILS:

I spoke to Dave regarding glass recycling at the Cumberland MRF. He indicated the glass is manually sorted and then Neighborhood Recycling in Scoudouc, NB picks it up. He estimates they recycle 15 tonnes/yr.

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VERBAL CONTACT REPORT

PROJECT	Glass Study		**DATE**	July 28, 2006
ORGANIZATION	Owens Illinois		**PAGE**	**1**
CONVERSATION between	Chris Roach	**(SNC♦Lavalin)**	**CONTACT TYPE:**	
and	Oscar Robicheau		☒ **Telephone** ☐ **Meeting** ☐ **Other:**	
COPY TO			**PROJECT No.**	017075

COMMUNICATION DETAILS:

Oscar confirmed that H&H Recovery in Yarmouth, NS ships glass to them. The glass is hand sorted and excellent quality. Owens Illinois receives only clear glass from H&H and usually gets 2-3 load/year.

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