



**Halifax C&D Recycling Ltd.**

**Resource Recovery Fund Board Inc.**  
Mattress and Box Spring Study  
Final Report

MAY 2009

Final Report  
Nova Scotia Mattress and Box Spring Study



Prepared for:  
Resource Recovery Fund Board Inc.  
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May 2009



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April 30, 2009

Resource Recovery Fund Board Inc.  
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Attention: Jeff MacCallum  
Director, Business Development

Dear Mr. MacCallum:

Please find enclosed two hardcopies and an electronic copy of the Final Mattress and Box Spring Report that investigates the feasibility of a mattress and box spring recycling program in the Halifax Regional Municipality and Nova Scotia.

If you need any additional information or have any questions, please do not hesitate to call me at (902) 876-8644.

Regards,

Halifax C&D Recycling Ltd.

Nick Russell  
Business Development Manager



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## **Executive Summary**

Mattresses and box springs continue to challenge many aspects of the current Nova Scotia disposal system. Diversion of bulky materials is also an issue that has garnered a lot of recent attention and a better method to handle mattresses and box springs in Nova Scotia is at the forefront. That being said, resources available to handle these challenges are limited and are in high demand. Having a clear, accurate investigation conducted that evaluates the situation of mattresses and box springs in regards to broad Nova Scotia waste management strategy seems to be the logical next step of progression if our disposal methods for these materials are going to change.

Halifax C&D Recycling Ltd. noticed the need for relevant information on mattress and box spring management and its relation to the current Nova Scotia environment. Much of the information collected in this study is specific to Halifax and Nova Scotia.

The study outlined five dismantling options and four collection options they could be applied to a mattress and box spring management program in Nova Scotia.

Because of the considerable amount of options available in setting up a mattress and box spring management program we do not make recommendations as to how to construct a successful program but rather provide information required when developing a management strategy.

One thing became very clear to use as we began looking at management programs; a disposal fee per mattress will be required unless some government agency is willing to subsidize the costs. Values for components in most cases are all but lost when factors like transportation are realized.

In terms of realized costs and revenues, a mattress and box spring recycling facility is not a money making venture. The variable that may justify a program would be the hidden costs passed on to our landfills and ultimately the tax payer.

Mattress and box Spring recycling in Nova Scotia is a good idea but it would need to be implemented to fit our local environment and has to have the support of all stakeholders involved.

## INTRODUCTION

### Issue of concern

End of life mattresses and box springs have served as a particular challenge to municipal and private waste managers for many years; not only in Nova Scotia, but also throughout the entire world. They are bulky, resistant to compaction, difficult to disassemble, made of several dissimilar materials and highly absorbent. All these factors combine to make them a troublesome component of the MSW waste stream, particularly when attempting to identify practical diversion opportunities.

### Current disposal approach and concerns

Mattress and box springs in Nova Scotia can currently end up in two streams once they are discarded. The first and most traditional stream would be a landfill. Mattress and box springs make it to a landfill through curbside collection and direct hauling to the facility.

Although Halifax C&D does not regularly accept mattresses and box springs, there are situations where they do enter one of our construction and demolition waste management facilities. Typically, this is because waste haulers may not load their bins or roll-off containers themselves or these containers are not locked up so material (mattresses and box springs) that is not meant to be in a particular container will find its way in by someone who is looking for a quick way to discard it. Mattresses that arrive at our facilities and the ones that enter the municipal landfill sites through curbside collection are typically contaminated with materials like soils and food waste. This is an obvious result of cross-contamination that has a negative effect on the potential to divert specific materials in the mattress or box spring.

Discussions were had with many regional officials responsible for waste management in Nova Scotia to understand where and how mattresses and box springs are disposed of. The majority of the regions do offer curbside collection to residential taxpayers once or twice a year at no additional charge. The regions that do not offer curbside pick-up have residents and businesses haul the mattresses and box springs directly to a transfer station or municipal landfill. All mattresses that are currently brought to a municipal facility or discarded curbside will ultimately end up in one of Nova Scotia's second generation landfills. There are some situations where second-hand stores collect mattresses and box springs directly from residents or retailers but this is limited.

The table below summaries the information collected from these discussions:

COUNTY/REGION	CURBSIDE PICK-UP	DROP-OFF FEE (RESIDENTIAL)	DROP-OFF FEE (COMMERCIAL)	ADDITIONAL NOTES
Region 5-Valley	One Spring/ One Fall	\$98/tonne with \$4 minimum fee	\$98/tonne with \$4 minimum fee	<ul style="list-style-type: none"> <li>Don't have indoor storage space for mattresses but could find room outside.</li> <li>Goes to Kaizer Meadows Landfill</li> </ul>
Region 7-Municipality of Argyle, Clare, Digby, Yarmouth and town of Digby and Yarmouth	One Spring/ One Fall	Up to 200 Kg at no charge	\$120/tonne with \$5 minimum fee	<ul style="list-style-type: none"> <li>Have a small amount of storage space.</li> </ul>
Municipality of East Hants	One bulky item every pick-up (two weeks)	No charge	\$96/tonne	<ul style="list-style-type: none"> <li>Commercial units are able to put two bulky items out every pick-up.</li> <li>Goes to West Hants Landfill</li> </ul>
Antigonish County	Once in the spring the county puts out a container for residents to put mattresses and box springs in.	No Charge	\$100/tonne	<ul style="list-style-type: none"> <li>Goes to Guysborough Landfill</li> </ul>
Guysborough County	Year round pick-up	No Charge	\$69.09	<ul style="list-style-type: none"> <li>Are hoping to do some research on mattress recycling.</li> <li>Goes to Guysborough Landfill.</li> </ul>
Region 4- Halifax Regional Municipality	One bulky item every pick-up	\$115/tonne with \$5 minimum	\$115/tonne with \$5 minimum	<ul style="list-style-type: none"> <li>Mattress and box spring considered one bulky item.</li> <li>Goes to Otter Lake Landfill</li> </ul>
Cape Breton Regional Municipality	Once in the spring	No Charge	\$80/tonne	<ul style="list-style-type: none"> <li>Would be interested in recycling mattresses if it meets department's mandate.</li> <li>Goes to Guysborough Landfill</li> </ul>
Colchester County	One Spring/ One Fall	No Charge (except Truro, Stewiacke and Millbrooke who pay \$75/tonne with \$3 minimum)	\$75/tonne	<ul style="list-style-type: none"> <li>Have had issues handling mattresses and box springs that were left out too long before curbside pick because rodents would live inside them.</li> <li>Goes to Colchester Balefill</li> </ul>
Pictou County	No	\$102/tonne	\$102/tonne	<ul style="list-style-type: none"> <li>All mattresses and box springs are brought to Mount Williams Transfer Station.</li> <li>Summer Street Industries was looking into dismantling mattresses and had arrangement for storage at county transfer station but it did not get started up.</li> <li>Volumes of mattresses and box springs delivered comes in random spurts from 1/day to 20/day. Do not know why.</li> <li>Because mattresses are shipped to Guysborough for disposal there is an issue with compaction and its affect on the shipment weight.</li> </ul>
Region 6- Town of Windsor, Mahone Bay, Lunenburg, Bridgewater, Lockeport, Shelburne and the Municipal Districts of West Hants, Chester, Lunenburg, Region of Queens and Shelburne	One Spring/ One Fall (except West Hants and Barrington- all year)	Varies	Varies	<ul style="list-style-type: none"> <li>Mattresses and box springs would go to either Queens County landfill, Kaizer Meadows or West Hants Landfill depending on location.</li> <li>Do not know of any one recycling mattresses in the region.</li> </ul>

All of the mattresses and box springs collected at municipal facilities were eventually sent to a second generation landfill. We were able to contact four of these landfills and notes pertaining to those discussions are summarized below.

LANDFILL	NOTES
<b><i>Otter Lake</i></b> <b>Exit 3 off HWY 103,</b> <b>Halifax</b>	<ul style="list-style-type: none"> <li>• Accept mattresses and box springs at the landfill.</li> <li>• Do not track the amount of mattresses and box springs that enter the landfill.</li> <li>• At our request did track mattress amounts for one week but stopped once it was determined there were too many variables to get accurate figures over the short study period. Over that one week period roughly 150 mattresses were recorded.</li> <li>• Do not have anyone recycling mattresses from their facility.</li> </ul>
<b><i>Guysborough</i></b> <b>151 Waste</b> <b>Management Road,</b> <b>Meagher's Hill</b>	<ul style="list-style-type: none"> <li>• Accept mattresses and box springs at the landfill.</li> <li>• Do not track the amount of mattresses and box springs that enter the landfill.</li> <li>• Have had issues with metal coils getting caught in landfill equipment.</li> <li>• Soft spots are not an issue because mattresses are dispersed around the open face of the landfill we possible.</li> <li>• Receive Mattresses and box springs from all of Cape Breton and Guysborough, Antigonish and Pictou counties.</li> <li>• Do not have anyone recycling mattresses from their facility.</li> </ul>
<b><i>Colchester Balefill</i></b> <b>188 Mingo Road,</b> <b>Exit 18, HWY 104,</b> <b>Kemptown</b>	<ul style="list-style-type: none"> <li>• Accept mattresses and box springs at the landfill.</li> <li>• Do not track the amount of mattresses and box springs that enter the landfill.</li> <li>• Do not have any operational issues when processing mattresses and box springs.</li> <li>• Baler does compress mattresses much better than standard compactors.</li> <li>• Do not have anyone recycling mattresses from their facility.</li> </ul>
<b><i>Kaizer Meadows</i></b> <b>450 Kaizer Meadow</b> <b>Road off HWY 14,</b> <b>Mun. of Chester</b>	<ul style="list-style-type: none"> <li>• Accept mattresses and box springs at the landfill.</li> <li>• Do not track the amount of mattresses and box springs that enter the landfill.</li> <li>• Receive Mattresses from Lunenburg and Chester Municipality and the entire valley region.</li> <li>• Spread large amounts of mattresses out when putting in landfill to avoid soft spots.</li> <li>• Do not have anyone recycling mattresses from their facility.</li> </ul>

All of the landfill operators we spoke did fell that mattresses and box springs where an issue at their sites. The biggest issue was the lack of possible compaction standard landfill compactors could achieve. The Colchester Balefill is the one exception because their baling equipment does not have any issue achieving regular compaction rates when handling mattresses. Maximum compaction rates in a landfill for mattresses have been estimated to be between 50% and 65% if they are not baled.

All landfill sites except Colchester Balefill disperse large loads of mattresses and box springs that enter the site to decrease to opportunity for metal coils to wrap around expensive equipment and create damage. Dispersing large quantities of mattresses through an open landfill cell also combat the threat of dangerous “soft spots” that are a result of isolated areas that have low compaction. These soft spots have been report to cause serious injuries to equipment and their operators when they are travelled over.



Mattresses and box springs also do not degrade very well in landfills and the air voids created in the steel coils promote harmful bacteria growth (odour).

All of the landfill operators we spoke to were aware of these issues and were also open to the idea of participating in a provincial mattress recycling program if it would benefit their operation.

### **Objective of study**

The objective of the Mattress Research Project is to assess the feasibility of a mattress recycling facility in Nova Scotia. There is a focus on the Halifax Regional Municipality (HRM) context because it would be the preferred location in Nova Scotia to establish a mattress recycling facility based on population and thus number of available mattresses and box springs. If information collected for this study could be applied to the entire scope of Nova Scotia and was determined to be a worthwhile investment of resources to investigate, then the attempt was made to include relative information for discussion within this report.

### **Halifax C&D Recycling: A brief history**

Halifax C&D Recycling Ltd. has been in business since 1995. Our operations include the management of a processing facility in Goodwood, a transfer station in Dartmouth, a construction and demolition debris landfill in Antrim, as well as a fleet of transportation and heavy industrial vehicles/equipment, a growing amount of trained employees and multiple horizontal grinders.

The company's growth can be in part attributed to our commitment to innovation in the field of waste diversion. This innovation is highlighted by the proprietary system developed exclusively by our company which turns tear-off asphalt shingles into two new marketable products as well as our system which turns most types of C&D plastic into multi-purpose posts.

We currently accept most of the construction and demolition wastes generated in the Halifax Regional Municipality and have been successful in reaching the 75% diversion target imposed by the municipal government (By-Law L-200).

### **Role of Halifax C&D in this study**

Halifax C&D Recycling Ltd. had determined that the current disposal approach for mattresses and box springs has some concerns that may have potential solutions. Being a company that is in the waste disposal/recycling sector, the company has a vested interest to see that our mattresses and box springs do not end up in a landfill. Results of this study may also be in line with a new diversion strategy developed by our company to change the way select materials are discarded in the HRM. We recently initiated a process to amend the zoning designation at our Goodwood facility. If successful, this amendment would give our company the room needed to separate targeted waste streams that are not currently being diverted. Information from this study will play a large role in determining if mattresses and box springs will be part of our diversion strategy as well as the revised Goodwood facility layout.

## Identification of project funding support

Funding for this report comes from two sources; the Resource Recovery Fund Board Nova Scotia (RRFB NS) has agreed to financial support Phase 1 of the study with a non-repayable contribution. Halifax C&D Recycling Ltd. is responsible for all remaining costs occurred with the completion of this study.

## 1.0 Project Methodology

The mattress research project has been broken into three distinct phases. **Phase 1** of this research project was geared towards collecting the information needed to determine if markets do exist within Atlantic Canada for wool, cotton, polyurethane and vinyl from mattresses and box springs. The marketing phase of this project (**Phase 2**) was centered on collecting the information needed to determine if a fully functioning mattress recycling facility is feasible. This information was collected generally from outside sources as opposed to Phase 1 where collected information came primarily from internal sources.

**Phase 3** of this research project involved compiling all the information collected in Phase 1 and 2, (along with other information formerly gathered) and evaluating the feasibility of operating a mattress recycling facility in Nova Scotia. The Phase 3 effort also involved the compilation of estimated costs to manage mattresses and box springs in different environments.

Specific questions were also developed in the study proposal that we set out to answer. Each phase had its own set of questions. The order in which these questions were answered in this report does not align with the format/order in which they were originally outlined. Each phase and correlating questions are detailed below:

### **The objective of Phase 1 will be to answer the following questions:**

- What is the percentage (by weight) of the respective components of a typical mattress and box spring?
- What specific characteristics do the components in a typical mattress and box spring have?
- What is the most suitable way to disassemble specific types of mattresses and box springs?
- What is the most efficient, effective way to operate a mattress recycling facility?
- What are the major issues when operating a mattress recycling facility? Can they be overcome?

### **The objective of Phase 2 will be to answer the following questions:**

- How will a facility arrange for individuals and businesses to drop mattresses and box springs?
- What value would these material characteristics have to specific Nova Scotia/Atlantic Canadian businesses?

- Are there suitable markets for these components in Nova Scotia/Atlantic Canada?
- What value would these potential markets offer for the mattress and box spring components?
- What volume of mattresses and box springs are discarded in one year within Nova Scotia?

**The objective of phase three will be to answer the following questions:**

- What is the cost per mattress or box spring to manage a successful mattress recycling facility/program in Nova Scotia?
- In the current environment could a mattress recycling facility successfully operate in Nova Scotia?
- What changes, if any, need to be made to the current environment for a facility to successfully operate in Nova Scotia?

### **Period over which the study was completed**

Approval for project funding from the Resource Recovery Fund Board was received on October 24, 2008. Hand-dismantling beginning on November 25, 2008 and concluded on December 16, 2008. Mechanical shredding and separation trials took place from January 5, 2009 and concluded on February 13, 2009. Collection of information used in this study began on November 3, 2008 and concluded April 30, 2009.

## **2.0 Material Characterization**

### **2.1 Quality**

#### **Description of dismantling, separation and weighing program, including results**

It has been reported by the International Sleep Products Association that 70% of new mattress sales come from customers replacing an old one.

It should be noted that the test batch size (as outlined in Appendix D, Table 1&2) was reduced from the number suggested in the September 5, 2008 mattress study proposal. Originally, 300 mattresses and 100 box springs were going to be dismantled but that was changed to 100 mattresses and 30 box springs. It became clear very early in the dismantling phase of the study that efficiencies and quantitative data collected would be sufficient to generate an accurate depiction of the samples.

The test batch of mattresses and box springs were collected at our Halifax and Dartmouth facilities. We do not typically accept mattresses at any of our sites but had allowed them for a limited time for use in the feasibility study. Mattresses and box springs that entered our facility were generally very dirty and in most situations had had some exposure to the elements (e.g., rain and snow).

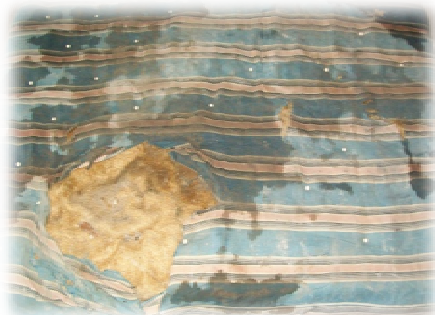


Figure 1: Typical discarded mattress



Figure 2: Mattress components



Figure 3: Hand dismantling w/knife



Figure 4: Dismantling w/grinder



Figure 5: Hand tools used for dismantling



Figure 6: Horizontal grinder



Figure 7: Mattress passing through HCD machine



Figure 8: HCD mattress machine



Figure 9: Component Shredder



Figure 10: Gaylord boxes of pre-shredded components



Figure 11: Shredded Polyurethane



Figure 12: Dismantled mattress coils

## 2.2 Quantity

### Suggested value for HRM/Nova Scotia

Determining the best method to estimate the volume of mattresses discarded annually in Nova Scotia was a very difficult task. We were not able to find any concrete formula developed by other groups that could give us a range.

We contacted many of the local retailers to see what volumes of mattresses were being sold in a given area and work backwards from there. This proved to be unsuccessful because of store privacy issues. The intent was to get a sense of new mattresses sold at local stores and then determine the population within that service area.

An attempt to track mattresses that enter landfills also turned out to be an unacceptable method to determining mattress volumes because it was extremely difficult to count units that were buried deep inside garbage loads being tipped. When a large load of mattresses came from a hotel then it dramatically increased the weekly figure in a matter of minutes. The variables were considered too high to get an accurate range.

The method we used was to collect the entire discarded mattress estimates found from a variety of public sources and divide it by the area's population to get each estimates

mattress/person/year number. This number could also represent the areas estimate for mattress life in years. Once all of the areas numbers were calculated they were averaged with equal weights given to every estimate. This number of 12.17 mattress discarded per person was then used in comparison to the Nova Scotia and Halifax population. We did not find one estimate of discarded box springs over the course of the study so the decision was made not to attempt to calculate a figure.

	POPULATION	DISCARDED MATTRESSES	MATTRESS/PERSON
American Recycler Estimates (USA)	300,000,000	40,000,000	7.5
NSDOE Unofficial Estimates (Nova Scotia)	940,000	52,722	17.8
Hennepin County Estimates (Twin Cities, Minnesota)	3,502,891	300,000	11.7
Minnesota Pollution Control Estimates (Minnesota)	5,220,000	600,000	8.7
Recyc-matelas Estimates (Quebec)	1,542,000	250,000	6.2
St. Vincent de Paul Society Estimates (San Francisco Bay Area)	7,400,000	350,000	21.1
AVERAGE			12.17
<b>Nova Scotia Mattress Estimates/year</b>	<b>940,000</b>	<b>77,243</b>	
<b>Halifax Mattress Estimates/year</b>	<b>385,000</b>	<b>31,637</b>	

With regards to mattress size breakdown, Conigliaro Industries of Boston has determine that in a 125 unit batch that 33% of the load were twin size, 23% were full size, 34% were queen size and 10% were king size. The size of all mattresses used in our study was taken but because of the large variations in dimensions we did not classify each individual unit into a specific size. Many of the mattresses had become deformed over time and their original dimensions were not determinable.

### 3.0 Dismantling Options

#### North American dismantling operations

##### *Halifax Regional Municipality*

There are no operational mattress and box spring dismantling facilities in the HRM that we were able to locate.

Parker Street Furniture Bank, a not for profit organization located in Halifax, collects old mattresses from the HRM and then gives them away to needy individuals. They only do minor repairs if required for re-sale but have never dismantled them with the intention of separating the different components to eventually recycle. Simmons Mattress Gallery and Leon's have arranged for Parker Street to collect old mattresses from their customers who purchase new ones from one of their stores. Of the mattresses and box springs that arrive at the Parker Street furniture bank, roughly 50% come from individuals and the other 50% come from commercial groups. Last year the organization collected 2582 mattresses and box springs from the HRM but the request for mattresses and box springs larger than Parker Street can supply. An

issue this organization has with their mattress distribution program is that any mattress or box spring that is brought to them with stains or bed bugs need to be disposed at the landfill with Parker Street having to pick up the bill at \$115/tonne.

The Salvation Army will also accept old mattresses in reasonable condition for re-sale at one of their furniture banks. I assume there are additional charitable groups within the HRM that we have not contacted who will also collect mattresses and box springs and offers them to individuals at a minimal or no charge.

### ***Nova Scotia/Atlantic Canada***

Halifax C&D was not aware of any facilities in Nova Scotia disassembling mattresses and box springs in a large quantity.

In Renous, New Brunswick the CorCan (Corrections Canada) Facility was accepting old mattresses and box springs from Nova Scotia businesses for roughly \$10/mattress. The disposal fee per mattress did not typically cover the transportation cost (Armour Transportation) to get them to the Renous facility. The CorCan facility always covered the transportation costs. They could typically fit 200 mattresses in a 53' trailer. It was never an operation that generated profit. Although some of these mattresses and box springs were dismantled and the components sold, the majority would be reconstructed and distributed to suitable organizations (usually the Department of National Defense). When the operation was at its peak capacity they had 7 inmates working who could reconstruct roughly 100/week each. This facility had stopped accepting mattresses and box springs for reconstruction in the summer of 2008. They currently only construct mattresses from virgin materials but they may start accepting old mattresses if there is no other work for the inmates to complete.

Kelly's Trading in Cambridge accept old mattresses from Jordan's Home Furnishings. The delivery service at Jordan's will pick-up old mattresses from customers who are having a new one delivered and then transport them to Kelly's Trading. Kelly's Trading fumigates the mattresses that are in reasonable condition and sells them for between \$25 and \$150. They did not have a idea how many mattresses they were collecting from Jordan's.

Reportedly, Centre Jodrey, located in Clare, is in the process of initiating a study on recycling furniture and (potentially) mattresses and box springs.

### ***Other Facilities***

There are successful mattress and box spring recycling facilities in Montreal (*MattCanada*), Boston (*Conigliaro Industries*), San Francisco/Oakland (*St. Vincent de Paul Society & Bed Busters*), Vancouver (*mattressrecycling.com*), Australia (*Dreamsafe*), Scotland (*Springback Project*) and Minnesota (*Northeast Minnesota Mattress Recycling Program*). These facilities all tend to operate in a similar manner, where mattresses are collected for a charge, separated into two disassembling streams depending on their characteristics, disassembled with specific materials collected and

prepared for shipping to end-markets with the exception of MattCanada and their processing equipment.

Established mattress recycling facilities in other jurisdictions tend to operate in relatively simplistic fashion. The technology involved in disassembling mattresses and box springs has not developed much from when the concept began. This may be because the R&D and capital costs required to develop an advanced processing technology are not justifiable in comparison to the potential profit it may generate. The only exception would be the system offered by MattCanada in Montreal that is almost completely automated.

Mattresses and box springs facilities operated by government organizations typically accepted items at public drop-off centers that also receive a variety of divertible items. To see a standalone mattress recycling collection facility was not common especially in less populated areas that would be comparable to Nova Scotia. A charge to private customers for mattresses and box springs disposal at these facilities ranged from \$10 to \$25/each with the average being \$15/each and were often reflective of the size. It seemed that most of the mattress and box spring recycling facilities received the majority of items from businesses and organizations that have pre-arranged to drop them off. They seem to be more inclined to pay a fee per mattress/box spring because it would help them meet their mandate of being environmentally conscious and/or they can sell the idea of mattress diversion to customers who in turn would offset some of the disposal costs.

Potential mattress collection groups that have historically been responsive to the idea of a mattress recycling facility would be stores that sell mattresses/box springs (Sears, Simmons, Gallery One, etc.) and hotels that can promote the image of a “green” business, military facilities and hospitals that are often driven by public pressure to partake in environmental practices, and universities who tend to be progressive in the area of environmental responsibility. Discounts for businesses and facilities that bring in large volumes of mattresses and box springs were a common practice among privately operated facilities.

When an item is ready to be processed, a worker determines whether it will be hand disassembled or fed into a shredder. Some sources have suggested that as much as 40% of the mattresses and box springs are best sent to a shredder while other facilities are operating with no shredder at all.

It will be important to keep the mattresses and box springs out of the rain because if wet, it makes the disassembling process messy, adds weight to the materials and often creates a powerful odour. Items that are wet typically are only shredded rather than hand disassembled. Other types of mattresses and box springs that may not be best suited for hand disassembling included heavily solid items, specific brands that have been identified to be hard to disassemble and also extremely old items.



## Identified options with noted advantages/disadvantages

***Processing a mattress or box spring using a horizontal grind-*** This method is fairly straight forward. The item goes in the grinder; it is ground into more manageable sizes and discharged into a container where it will be delivered to its end-market. A head-magnet will be included in the system to remove the steel. The only component that can be individually separated through this process is steel (ferrous materials).



Horizontal Grinder

Processing mattresses and box springs with a horizontal grinder requires high capital and operating costs and the potential volume of mattresses and box

springs that could be recovered in Nova Scotia would not justify these costs if the machine was used just for managing this waste stream alone.

We noticed that the metal coils in the mattresses began to get caught in the horizontal grinder's hammers. This was reason enough for us to not put more than three mattresses through the machine. We believe that it would be possible to modify the grinder's hammer mill so coils would not get caught but this would cost too much money for the purposes of this study.

***Hand dismantling a mattress or box spring-*** We attempted two methods of hand dismantling for this study. The first was using non-power tools while the latter method incorporated a disc grinder.

The employee first places the item on a flat, elevated work station and begins filleting it with a utility knife or drywall knife. A cut is made along the middle of the sides so the fabric cover can be pulled off the top. To remove the padding components the hog ties (staples) must be cut. This is the most time consuming portion of hand processing. Then the padding layer of wool, cotton and polyurethane are removed and collected in separate areas for further processing.

Some mattresses and box springs are better constructed than others which will add to the time it will take to hand disassemble. We have found out that most facilities average time for this form of processing to be between 10 to 15 minutes per mattress and box spring once employees has developed efficiencies. We do not feel that this number is realistic and would say the average hand disassembling time with no power tools is closer to 25 minutes as outline in our sample data.

A pneumatic shear may need to be used to cut larger hog ties that hold the items together and this should reduce processing time dramatically. Unfortunately we were not able to source out a pneumatic shear that would be suitable for this test.

Steel and wood cores are then removed and the bottom half of the fabric covering can be separated. Much like the grinder, additional processing of the separated materials will depend largely on the end- markets.

Wood will be shredded and used as an alternative fuel at facility capable of burning hog fuel or clean wood (i.e. Brooklyn Energy in Liverpool, NS) and steel could be sold to one of the many metal purchasing firms in the province.

The second method of hand dismantling used involved a disc grinder to cut the side walls and hog ties rather than having it done hand shears. This method significantly sped up the processing time. The major issue with this method was it created a fire



Figure: Hand dismantling a mattress

hazard. Sparks generated from the grinder cutting into steel coils and hog ties (staples) had in some instances caused fabric material to smolder. If this method was done in a fully operational facility that chances of fabric igniting are extremely possible.

The risk of an employee getting hurt by the grinder is also high. If the disc on the grinder gets caught on material it can kick back in the direction of the worker.

***Halifax C&D processing system-*** After conducting all of the hand dismantling tests we saw the potential for increased efficiency using a relatively simple method. As discussed, the majority of the processing time came from removing the hog ties that hold all of the components to the steel coils. If a semi-automated machine could cut these hog ties then efficiencies could be realized and it may make a processing facility in Nova Scotia more feasible.

The premise behind our test equipment would be that a mattress could be dragged over grinding discs that cut the hog ties. This would be repeated for all four sides until the different layers of material were freed from the steel coils. Multiple discs were placed on a plain to increase the chances that all material would be freed for a variety of mattress sizes. We tried many different types of grinding discs to see which ones handles the mattress components best while creating a limited amount of sparks. The preferred disc was one used for cutting masonry.



Although the system we created did operate, it had little success in completely cutting the material away from the coils. If a mattress side was not completely level then contact with the grinding discs was lost in several locations. Another issue was that slices of material became entangled in the shaft of the machine and caused it to jam.

#### **HCD Mattress Processing Machine**

With some more time and modifications we feel that this machine does have the potential to work efficiently. The basic idea used by this machine can work but our system would not be something a facility could use to dismantle any large quantity of mattresses.

***MattCanada processing system-*** This mattress dismantling system is sold for \$185,000 USD and the box spring dismantling system is sold for \$55,000 USD. It is the only dismantling system for sale that we were able to find. It would take one and a half months to build if ordered and both systems have a two year warranty. Since there are patented features to these systems it was difficult to gather information but a video of the machine operating can be found at:  
[www.mattcanada.com/Mattress\\_Dismantling\\_System.html](http://www.mattcanada.com/Mattress_Dismantling_System.html)

Once of the largest benefits with purchasing this system is that MattCanada has said they would take all of the separated mattress components from a Nova Scotia operation. It was not clear if this offer would still be accepted if the system was not purchased from them.

A summary of the advantages and disadvantages of each dismantling option is below:

	<b>ADVANTAGES</b>	<b>DISADVANTAGES</b>
Hand dismantling	<ul style="list-style-type: none"> <li>• Best separation of components</li> </ul>	<ul style="list-style-type: none"> <li>• Labour intensive</li> <li>• Health and safety concerns</li> </ul>
Hand dismantling with grinder	<ul style="list-style-type: none"> <li>• Low capital cost</li> <li>• Faster than using hand tools</li> </ul>	<ul style="list-style-type: none"> <li>• Increased fire potential</li> <li>• Safety concerns</li> </ul>
Halifax C&D processing system	<ul style="list-style-type: none"> <li>• Relatively low capital cost</li> <li>• Nova Scotia product</li> </ul>	<ul style="list-style-type: none"> <li>• Needs to be modified</li> <li>• Only used in trials not functioning operation</li> </ul>
Grinder	<ul style="list-style-type: none"> <li>• Can be used to process a variety of materials</li> <li>• Enormous throughput capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Highest capital cost</li> <li>• Only separates metal</li> </ul>
MattCanada processing system	<ul style="list-style-type: none"> <li>• Good separation of components</li> <li>• Fast processing time</li> <li>• Established processing system</li> </ul>	<ul style="list-style-type: none"> <li>• High capital cost</li> <li>• No local service technicians</li> </ul>

## Summary of health and safety issues

The disassembly and processing of mattresses presents several health and safety concerns including:

- Puncture hazards; from cutting tools, metal springs, jagged plastic and wood edges.
- Inhalation hazards; from dust (with a potential mould component) generated during mattress disassembly and processing.
- Eye hazards; from debris generated during cutting and grinding activities.
- Hearing hazards; from equipment including grinders and portable power tools.
- Physical hazards; as associated with lifting and the use of portable power tools.

Disassembly and processing activities will be conducted in accordance with Provincial health and safety legislation, including the provision of required training to personnel.

Acknowledging the potential hazards listed above, the following personal protective equipment (PPE) will be utilized by staff involved in disassembly and processing activities:

- Eye protection (face shield, goggles or safety glasses)
- Hard hat
- Dust mask

- Hearing protection
- Safety boots
- Sturdy gloves
- Long pants and long sleeved shirt

## 4.0 Collection Options

### Summary of options

A summary of potential collection options for a mattresses and box spring recycling program are below:

COLLECTION OPTIONS	ADVANTAGES	DISADVANTAGES
Drop-off program at retailer locations who then sends it to central processing sites	<ul style="list-style-type: none"> <li>• Plenty of accessible drop-off locations</li> </ul>	<ul style="list-style-type: none"> <li>• Considerable logistic planning required</li> </ul>
Scheduled curbside pick-up program (just mattresses and box springs) that then sends it to central processing sites	<ul style="list-style-type: none"> <li>• Infrastructure generally in place already</li> <li>• Low additional costs</li> </ul>	<ul style="list-style-type: none"> <li>• Possible influx in mattress and box spring volumes may be difficult to manage</li> <li>• Mattresses and box spring would be more likely to become wet or contaminated then other options</li> </ul>
Landfill site drop-off areas/containers with processing sites on location	<ul style="list-style-type: none"> <li>• Low front-end transportation costs</li> <li>• Could fit in nicely with present landfill diversion operations</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Sites may not have sufficient space available</li> <li>• Increased travel distances required by citizens</li> </ul>
Implement stewardship program and have industry manage solution	<ul style="list-style-type: none"> <li>• Minimal government resources requirements</li> </ul>	<ul style="list-style-type: none"> <li>• Solution may not be best for Nova Scotia</li> <li>• Could mean</li> </ul>
Status Quo	<ul style="list-style-type: none"> <li>• No direct risk</li> </ul>	<ul style="list-style-type: none"> <li>• Negative effect on landfill management</li> <li>• Increased costs to landfills</li> <li>• Difficult to separate mattresses from the waste stream</li> </ul>

**Drop-off program at mattress and box spring retailer locations-** Much like the Nova Scotia tire stewardship program currently in place, any location that sells mattresses or box springs in the province would collect old units at their facilities. A disposal fee could be charged to customers as they drop-off old mattresses and box springs at these retail locations but the hope would be for this option to spawn into a program that collects a disposal fee at the time a customer purchases a new mattress or box spring so that funds are collected and in the system right away. It would also significantly decrease the risk that individuals may avoid paying the stewardship fee and dump the mattress or box spring in an illegal location.

These mattresses and box springs stored at the retail locations would then have set pick-up dates when the units are brought to a central mattress recycling facility. The associated transportation costs would be covered by a portion of the disposal/stewardship fee. This program could most likely be managed by the Resource Recovery Fund Board or the Nova Scotia Department of Environment.

A survey of random mattress retailers across Nova Scotia was conducted. We asked them if they currently accept customer's old mattresses and box springs after they purchase a new one from their store, if they charge a customer a fee for this service and any other relative information on this service. The information collected is below:

RETAILER	ACCEPT	CHARGE CUSTOMER	WHAT IS DONE
Bedroom Depot- Dartmouth	No	N/A	
The Brick- Halifax	Yes	No	Employees can not touch old mattresses (workers comp rule). Supply plastic bags to customers to put mattresses in. Roughly 50% of customers use service. Returned mattresses get cleaned and resold at a discount price. Old mattresses stored and sent to landfill.
Jordan's Home Furniture- New Minas	Yes	No	Use new mattress plastic covers and put old ones in. Store on-site until Kelly's Trucking picks up. Majority end up getting re-sold through Kelly's used furniture store and the remainder go to a landfill.
Burke's Countrywide Furniture- Sydney	Yes	Yes- usually \$10 to \$15	Put old mattresses in plastic cover when picking up from a residential customer. Roughly 20% of the customers use this service. Mattresses are stored and then sent to the landfill.
Comfort Foam & Fibre	No	N/A	
Hawboldt's- Windsor	Yes	No	Collect old Mattresses when delivering a new one. Roughly 10% of customers use this service. Mattresses are brought back to the store and put

			into the garbage dumpster.
Manorhouse Furniture- Halifax	Yes	No	Collect old Mattresses when delivering new one. Roughly receive 1/week. Are discarded in garbage container and sent to landfill.
Leon's Furniture- Kentville	No		Leon's Store in Dartmouth was sending good condition used mattresses to Parker Street.
Schwartz Furniture	Yes	\$20	All four locations accept old mattresses. They are taken back to the stores and put in the dumpster for removal to the landfill.
Sears Home- HRM	Yes	No	Will pick-up old mattresses and bring back to deliveries warehouse in Hammonds Plains. Roughly 10% of customers use this service. Put in 53' trailer and sell entire load to unidentified customer (confidential). They do not know what the customer does with it. Furniture may be put into the trailer too. Trailer fills as soon as a couple days to a couple weeks.
Simmons Mattress Gallery- Halifax	Yes	No	Baltic Delivery picks up old mattresses. Halifax store was sending good condition used mattresses to Parker Street.
Sommex Maritime- Stellarton	No	N/A	

***Scheduled curbside pick-up program-*** Many of the regions and municipalities across Nova Scotia already have a bulky item curbside pick-up program but in order to maximize a proposed mattress recycling facility all areas would need to be on board. By having a program available it ensures all mattresses are managed in quantity. If mattresses are handled at certain times of the year then volumes may be high enough in rural areas to justify special equipment to manage a pick-up program (i.e. unique hauling gear, reserved in-door storage)

***Implement stewardship program and have industry manage solution-*** This management program ties in with collection of old mattresses and box springs at retail locations. Regulation of mattress and box spring disposal can also tie into a stewardship program. The Nova Scotia provincial government has shown in the past that if certain waste streams can be diverted in a successful manor and has an appropriate funding program strategy then they have the power to ban them from disposal in landfills. A voluntary mattress and box spring management system that involves all stakeholders may be a model that can work in the province but it would be more difficult to achieve efficiencies and achieve the same level of province-wide acceptance.

***Landfill site drop-off areas/containers with processing sites on location-*** The option to drop mattresses and box springs is currently available at all municipal landfills but none of them are handling these units any differently than other waste streams. Since all disposed mattresses and box springs in Nova Scotia eventually end up at a landfill it would make sense to have a collection area on-site. These areas could either be

collection points for a central processing facility or on-site dismantling could take place at each location. Issues with available enclosed space at landfills will need to be addressed.

**Status quo-** The cost to manage a mattress and box spring may be deemed too high after evaluation of all options is completed. We have constructed two basic business financial plans for a mattress and box spring dismantling facility to help evaluate the situation (see Table 3 &4). These plans do not include collection costs and are based on an individual or business drop-off program.

## 5.0 Material Markets

### Separated components

The components found in discarded mattresses and box springs are shown in the table below as well as the percentage of the components compared to the total weight of the mattress or box spring. Data collected from our sample batch outlined in Table 1,



Typical mattress components

material break-down from a recent city of Toronto study and data collected by the United Kingdom company, Residua make up the table. The components weighed in all three studies were different but there are still some useful data inputs that can be compared.

	METAL	COVER	POLY	FELT	STRAW
HCD Study Results	50.3%	13.1%	8.3%	19.6%	3.0%
City of Toronto Study Results	56.0%	32.0%			
Residua, UK Study	54.4%	25.6%	10.0%	10.0%	-

It was very difficult to source out markets for post-consumer mattress and box spring components. The most encouraging market we found was in Montreal. MattCanada Ltd. was interested in taking all the components with the exception of the metal coils. They would cover the shipping costs if the material was baled and no value would be paid for the components. We got the impression that this end-market option would only be available if one of their mattresses dismantling machines was purchased. They would not give any information on the end-markets of the materials once they were shipped to Montreal.



In some larger markets it was estimated that up to 85% of a mattress can be recycled while in other areas with greater limitations that figured dropped to around 55% depending on the needs of the end-market.

Markets for polyurethane were found in the United States by using resources provide on the center for the polyurethanes industries website ([www.polyurethane.org](http://www.polyurethane.org)). These markets use the post-consumer polyurethane to produce several new products including a powder that can be used to produce new foam, carpet underlay, athletic mats and automobile foam. The market price for post-consumer polyurethane is closely affected by oil prices because it is a petroleum based material. Currently the market price is very low and is usually between .05 and .20 cents per pound. In the United States approximately 300,000 tonnes of flexible polyurethane scrap are recycled into carpet underlay and other products each year.

Shredded polyurethane, felt and mattress coverings were taken to Dalhousie Universities Minerals Engineering Center for testing with the result outline in Appendix A. Three series of tests were conducted on the materials to help generate a better picture of the components characteristics. The tests completed include an ash analysis, BTU summary and trace metal analysis. Dillon Consulting (Richard Smyth) used the data compiled by Dalhousie to summarize the findings and compare results. This summary can also be found in Appendix A after the test results.

Cotton felt can be used to make low-end carpet underlay, as filler for packing, in shipping pads, oil filters and in wall and car insulation. Two years ago the value for cotton felt was around .03 cents per pound but that is only if it is dry and relatively clean. Rumpel Felt ([www.rumpelfelt.com](http://www.rumpelfelt.com)) in Kingston, Ontario and Protac Industries ([www.protac-industries.com](http://www.protac-industries.com)) in Quebec may be interested in recycling felt but this was not confirmed.

We were not able to find any existing markets in the world for post-consumer latex. This is not a huge challenge because latex is rarely present in mattresses that are old enough to be discarded from what we can tell. The estimated life span of a mattress is 8 to 15 year for residential users but the majority of mattresses we dismantled in our test batch were estimated to be over 20 years old.

Steel coils were sourced to a local metal buyer and the fee offered was roughly \$75/tonne. In the past year metal prices have crashed so we expect the value of this material to increase eventually. The buyer had requested that we keep the amount of contaminates to a value lower than 10% by weight. These contaminates include any padding material that is still attached to the coils. The quality of the metal used in the coils is relatively low (12.5-15.5 gauge) which has a negative effect on the value.

Any wood that is separated from box springs can be used as fuel at any of the approved burning facilities across the province.

Ticking can be used as rags but this is only in limited demand. No markets could be found for post-consumer vinyl.

### **Market challenges associated with components**

The first issue encountered when an attempt was made to source out mattress and box spring components was the fact that the material needed to be dry and there needed to be a limited amount of contamination from soil or other discarded remnants. As mentioned earlier, the current disposal approach for mattresses and box springs in the province of Nova Scotia do not take into consideration factors that affect the potential end-value of dismantled components.

The largest quantity of the mattresses and box springs that enter the waste stream come from curbside collection. The second largest amount would come from large facilities that typically dispose in bulk loads directly to the landfill. It is important that mattress and box spring storage and processing be done in an enclosed area that shelters material from the elements. The investment in an adequate enclosed building will have to be high due to the bulky characteristic of mattress and box springs but it is a requirement if an operation is looking to sell components with the highest potential value.

Secondly, the distance and associated trucking costs to get mattress and box spring components to established markets is great. The closest established market for most components was either in Quebec, Ontario or Massachusetts because this is where most manufacturing takes place. With fuel costs expected to increase in the future it only makes it hard to justify trucking costs. A hidden cost to long distance hauling is the impact on the environment. Reducing a diversion programs carbon footprint should be a priority.

Thirdly, many of the recycled components (particularly metal and polyurethane) are sold like any other commodity meaning that a severe decrease in the market value caused by macroeconomic situations would have a direct impact on the feasibility of a local operation. Currently the price for low grade metal and post-consumer polyurethane is extremely low. In fact it is so low that many recycling facilities in close proximity to end-markets are not financially able to justify operating costs associated with separating mattress and box spring components.

## **6.0 Key Challenges and Potential Solutions**

### **Key barriers to establishing a sustainable mattress dismantling/recycling service in HRM/NS**

One of the biggest challenges to collecting mattresses and box springs would be to develop ways to attract the volumes of mattresses and box springs needed while at the same time generating a certain level of revenue to have a sustainable operation. We feel the biggest motivator for customers to use a facility that has a per item fee for disposal rather than put it out on the curb at no charge would be the benefit of

knowing they would be extending the life of the municipal landfill which ultimately means less tax money spent and also knowing that most disassembled materials would be recycled. Mattresses can currently be disposed of in the HRM at a cost of \$115 per tonne at the Otter Lake Landfill.

A partnership with the municipality and province is vital to our proposed facility developing any long-term success. The province and/or municipality will hopefully agree to ban mattresses and box springs from entering landfills once there is proof a successful mattress recycling program is feasible in Nova Scotia.

In all the facilities we researched it was noted that their operations were labour intensive. Human resource management was seen as a challenge in these facilities. Dismantling mattresses and box springs is a tough and dirty job but because the skill-set requirement to fill the position is low it can be difficult to justify an employee's wage that is much higher than the skill-set requirements. Finding a wage for employees that is not only in line with the business model but also the employee's expectations seems to be tough. The requirement to handle a full sized mattress requires at least two employees. In our test batch we had several mattresses that weighed over 80 pounds dry.

### **Lessons learned from other jurisdictions**

The advice we heard most when speaking with current mattress and box spring facility operators was to keep pre and post processed mattresses and box springs as dry and uncontaminated as possible.

The least amount of moisture and contaminants in the processed components will have a direct impact on its value in the open market. That being said the importance for producing high quality products is less important in Nova Scotia because issues like transportation costs currently almost eliminate the sale of materials to established end-users of high quality components.

In every operation that gave information on their financial situation it was clear that without a disposal fee on discarded mattresses and box springs, value generated from separated components was not large enough to support a business. Many of these businesses who required a disposal fee to function are in larger markets than Halifax/Nova Scotia and the opportunities for certain recycled components (polyurethane/cotton) to be sold at a relatively high price are common.

It was also clear that a good manager was required. The responsibilities for the facility manager included securing the needed volumes of mattresses and box springs to be processed, developing relations with specific material end-markets, monitoring/evaluating the business, as well as handling any other aspects of the facility that need attention. Since there are a lot of unique challenges associated with operating a new business in a relatively new market, strong leadership has added value.

The method used to dismantle mattresses and box springs needs to reflect more than just the cost per mattress. Depending on the end-market, one method may be better financially if you take into consideration all the potential costs and revenues. The benefit of hand disassembling items is that more materials can be separated while a shredder generally will only allow you to take the metal out of the processed items and all remaining components are land filled. The end-markets an operation is intending to sell are the most important factor that determines which system of processing is most suitable. For example, if all of the material with the exception of metal is going to be used as an alternative fuel then it would be beneficial to process all of the mattresses with a shredder; cutting down of processing time and increasing the feasibility of a successful operation but if there are lucrative markets for cotton and wool as a recycled liner in automobiles then we would hand disassemble mattresses and box springs to separate the materials.

Baling processed components so they can be stored on site without taking up a large amount space and increase size of transported loads to end-markets should be strongly considered when setting up a facility. The capital costs could potentially be justified if transportation and facility costs are high.

## Appendix A Lab Tests/ Evaluation

23-Feb-09

Halifax C&D Recycling Ltd.  
16 Mills Drive  
Goodwood, NS  
B3T 1P3  
Attention: Nick Russell

Re: Results of analysis on submitted samples.  
Major oxide analysis on ash (ashed at 700°C).

Oxide (Wt. %)	Mattress Foam Ash	Mattress Felt Ash	Mattress Cover Ash
Al <sub>2</sub> O <sub>3</sub>	7.05	18.99	8.51
BaO	12.93	5.09	0.210
CaO	10.43	13.71	20.25
Cr <sub>2</sub> O <sub>3</sub>	0.025	0.222	0.026
Fe <sub>2</sub> O <sub>3</sub>	8.42	3.29	6.19
K <sub>2</sub> O	4.43	0.83	5.84
MgO	2.28	0.64	2.74
MnO	0.11	0.045	0.11
Na <sub>2</sub> O	2.17	1.40	4.49
P <sub>2</sub> O <sub>5</sub>	0.67	0.29	1.47
SiO <sub>2</sub>	34.99	26.92	30.01
SO <sub>3</sub>	11.03	4.42	12.49
SrO	0.209	0.072	0.059
TiO <sub>2</sub>	0.76	20.22	5.63
V <sub>2</sub> O <sub>5</sub>	0.02	<0.01	0.01
ZrO <sub>2</sub>	0.043	0.021	0.056

Daniel  
Chevalier  
Manager, Minerals Engineering Centre

23-Feb-09

Halifax C&D Recycling  
Ltd.  
16 Mills Drive  
Goodwood, NS  
B3T 1P3  
Attention: Nick Russell

Re: Results of analysis on submitted  
samples.

<u>Sample</u>	<u>Wt % Ash (700°C)</u>	<u>BTUs/lb (As Received)</u>
Mattress Foam	2.37	11537
Mattress Felt	6.07	9645
Mattress Cover	3.57	8845

Daniel Chevalier  
Manager, Minerals Engineering Centre

28-Feb-09

Halifax C&D Recycling  
Ltd.  
16 Mills  
Drive  
Goodwood, NS  
B3T 1P3  
Attention: Nick Russell

Re: Trace metal analysis on ashed samples. Near total acid digest, ICP OES finish.  
Samples ashed at 800°C

Sample	Analyte (mg/kg)								
	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce
Mattress Foam Ash	15.6	33142	<20	14366	<1	<10	61526	106	45
Mattress Cover Ash	12.4	42806	45	215	<1	<10	133763	78	88
Mattress Felt Ash	10.0	95215	18	1213	<1	<10	96658	57	63

Sample	Analyte (mg/kg)								
	Co	Cr	Cu	Fe	K	La	Li	Mg	Mn
Mattress Foam Ash	16	168	389	57503	33288	36	115	10892	1063
Mattress Cover Ash	65	141	1120	42374	51941	52	80	15415	868
Mattress Felt Ash	228	824	489	24353	14913	32	98	3346	347

Sample	Analyte (mg/kg)								
	Mo	Na	Ni	P	Pb	S	Sb	Se	Sn
Mattress Foam Ash	21	23610	139	1935	2509	22548	47	<20	6705
Mattress Cover Ash	94	33053	85	7298	1062	55658	1966	<20	869
Mattress Felt Ash	7	11457	51	1507	2354	6519	1108	<20	198

Sample	Analyte (mg/kg)							
	Sr	Ta	Ti	Tl	V	W	Zn	Zr
Mattress Foam Ash	1272	<10	3630	<10	74	<10	2205	254
Mattress Cover Ash	486	<10	27050	<10	56	<10	4274	371
Mattress Felt Ash	439	<10	95825	<10	31	<10	1019	160

Daniel Chevalier  
Manager, Minerals Engineering Centre

**Prepared by Richard Smyth for Dillon Consulting/Halifax C&D Recycling Ltd.**

## **Evaluation of Test Results from Dalhousie University**

**April 30, 2009**

The diversion of derelict mattress waste from landfill to a recycling facility would be expected to generate recoverable values in the forms of wood, ferrous metal and combustible fuel streams.

The wood and ferrous values isolated from the derelict bedding materials can be blended with currently existing wood and iron recovery process streams.

The essentially organic based foam, padding and covering fabrics can be used as a supplementary fuel source for the generation of heat values. The ash contents of the three organic components are as expected with the foam displaying a 2.37 % by weight ash residue that equates to a 97.63 % by weight combustible organic portion. It would be expected that a large portion of the foam used in discarded mattresses would be flexible polyurethane foams. The ash composition is typical of that expected from a plastic compounded with a low level of inorganic filler (i.e. alumina, calcium oxide and silica) and a white pigment such as barium sulphate (i.e. barium oxide and sulphate)

The upper layers of the traditional mattress assembly consisted of an outer fabric cover and the heavier thick felt based padding between the top fabric and the inner foam core. The process of “felting” that in historical times consisted of “pressing” together wool in a wet state often in combination with salts dissolved in the water, has given rise to the pressing together of many different types of fibers both natural and artificial in current manufacturing processes. The fibers used in recent felt production are formed into thicker padding materials by heat or solvent softening of the thread surfaces then pressing the material to form the felt or “gluing” the fibers together into sheets. The felt portion of the waste bedding stream has an ash content of 6.07 % by weight and a combustible organic content of 93.93% by weight. The higher ash content of the felt portion of the stream and the composition of the ash is consistent with that expected for a mixture of natural furs, plant and artificial fibers that have been bonded together by a variety of physical and chemical techniques. The presence of the titanium dioxide, barium and sulphate is probably due to the various white pigments often found in artificial fibers and white felted materials.

The majority of the outer covers of discarded mattress would be expected to have been manufactured from woven fabrics that have been coloured or dyed. The cover waste stream has an ash content of 3.57% by weight which is the intermediate value of the three streams. The combustible organic content of the stream is thus 97.43%.

The covering fabrics would also be expected to have been manufactured from a mixture of artificial and naturally occurring fibers. Cotton and cotton fiber blends should probably constitute a sizeable portion of the fabrics used in the outer covering of the mattress. Cotton itself has an approximate ash content of 1.2% by weight. Typically the most abundant elements in the cotton ash are potassium, magnesium, iron, sodium, sulphur and phosphorus. The level of phosphorus in the cover ash is consistent with the assumption that the cover stream probably contains a significant portion of cotton fiber. The higher phosphate levels due to elevated cotton



content are also consistent with the presence of the higher sulphate levels observed without the elevated levels of barium found in barium sulphate pigmented fabric fibers. The silica content and the titanium dioxide values are probably due to the fillers and white pigmentation of artificial fibers.

In the tabulated analysis of the three waste stream ash samples, the levels of calcium, sodium, potassium, barium and magnesium oxides, are in single and double digit values of relative abundance. The elemental oxide compounds of the alkali metals (i.e. sodium and potassium) together with the oxides of the alkali earths (i.e. magnesium, calcium and barium) have the ability to dissolve silica and alumina in the molten state. The dissolving of the silica and alumina by the alkali metals and earths is the basic process for glass manufacture. It is possible that the residual ash from the combustion of the three waste streams may either, form a glass like “clinker” or contribute to the formation of a glassy type ash, in a mixed waste derived fuel combustion process. The more glass like the waste fuel ash is, the lower will be the tendency for trace quantity metallic elements in the combustion process ash to leach into ground waters.

## Appendix B      Contacts

Name: Brian Richard  
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Name: Burke's Countrywide Furniture, Sydney  
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Name: Comfort Foam & Fibre, Dartmouth  
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Name: Hawboldt's Furniture, Windsor  
Tel: (902) 798-2267

Name: Leon's Furniture and Appliances, Kentville  
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Name: Manorhouse Furniture, Halifax  
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Name: Simmons Mattress Gallery, Halifax  
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Name: Sommex Maritime, Stellarton  
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Table 1

Table 1  
Disassembled Mattress Data

Column 1	Brand	Length (in.)	Width (in.)	Height (in.)	Cubic Feet	Cubic Metres	Total Weight (lbs)	Metal (lbs)	Cover (lbs)	Poly (lbs)	Felt (lbs)	Straw (lbs)	Latex (lbs)	Hard Foam (lbs)	Wood (lbs)	Mem Foam (lbs)	Disassembly Time (min.)	Method
1	-	72	37	6	9.25	0.262	28	20	2	2	6						15	Hand grinder
2	King Koil	75	38	7	11.55	0.327	38	24	6	2	6						10	Hand grinder
3	-	74	38	6	9.76	0.277	28	20	2	2	2						10	Hand grinder
4	Castro Convertibles	72	54	6	13.50	0.382	52	18	4		12	14					20	Hand grinder
5	Sears-o-pedic- Prestige II	74	40	8	13.70	0.388	52	26	10	4	12						11	Hand grinder
6	-	78	59	9	23.97	0.679	78	52	10	6	8						8	Hand grinder
7	Sleep Suzy- Majestic	83	57	10	27.38	0.776	48		6	42							4	Hand grinder
8	-	74	39	4	6.68	0.189	16		4	12							3	Hand grinder
9	-	72	38	6	9.50	0.269	40	22	2		16						12	Hand grinder
10	-	78	52	5	11.74	0.332	56		4	8	46						7	Hand grinder
11	-	73	38	8	12.84	0.364	58	26	6		12	12					11	Hand grinder
12	Sears-o-pedic	73	38	7	11.24	0.318	52	24	8		18						13	Hand grinder
13	-	80	62	10	28.70	0.813	94	46	2	2	4				36		9	Hand grinder
14	King Koil- Posture Classic	70	50	6	12.15	0.344	44	26	16								8	Hand grinder
15	-	70	52	4	8.43	0.239	42	20	4		18						8	Hand grinder
16	Simmons- Fairliner Quilt	72	52	7	15.17	0.430	72	24	14		14	10					15	Hand grinder
17	Sears-o-pedic	82	58	11	30.28	0.858	68		22	46							5	Hand grinder
18	-	74	46	7	13.79	0.391	60	28	2		30						13	Hand grinder
19	Sears-o-pedic	73	52	8	17.57	0.498	62	38	10	4	8						14	Hand grinder
20	Springwall- Chiro Designer Series	74	57	6	14.65	0.415	66	34	8	4	16						20	Hand grinder
21	-	75	52	10	22.57	0.639	88	64	14	4	6						18	Hand grinder
22	-	73	53	7	15.67	0.444	50	32	2	4	8						13	Hand grinder
23	Luxury Fine- Imperial	74	52	6	13.36	0.379	42	26	4	2	6						8	Hand grinder
24	HF- Premier Collection	79	58	9	23.86	0.676	78	48	12	10	8						16	Hand grinder
25	-	70	52	5	10.53	0.298	32	20	2	10							7	Hand grinder
26	Sears-o-pedic- Series 153555	74	52	8	17.81	0.505	62	36	14	6	6						21	Hand grinder
27	-	71	30	4	4.93	0.140	12	6	2	4							3	Hand grinder
28	-	68	37	4	5.82	0.165	24	14	6		2						9	Hand grinder
29	Atlantic- Posture Ease	73	52	7	15.38	0.436	56	26	4		24						14	Hand grinder
30	Sealy- Hallbrook Back Saver	75	38	7	11.55	0.327	46	28	8	4	4						11	Hand grinder
31	-	73	38	6	9.63	0.273	36	24	2	2	8						10	Hand grinder
32	-	75	55	7	16.71	0.473	44	20	2		2				20		18	Hand grinder
33	Hotel Motel	79	55	7	17.60	0.499	60	26	2		4				28		13	Hand grinder
34	Simmons- Citadel Inn	72	53	7	15.46	0.438	68	24	6		24	12					20	Hand grinder
35	Sunny Side- FR Cotton Felt	70	54	7	15.31	0.434	82	36	4		40						7	Hand grinder
36	-	70	45	8	14.58	0.413	66	30	14	2	20						13	Hand grinder
37	-	74	51	7	15.29	0.433	48	28	8	2	8						21	Hand grinder
38	Ther-a-pedic- Chromedic 2000 (Qu)	76	60	7	18.47	0.523	66	40	6	6							11	Hand grinder
39	Serta- Supreme I	81	57	8	21.38	0.606	70	38	8		24						12	Hand grinder
40	-	76	51	6	13.46	0.381	34	22	4	2	6						8	Hand grinder
41	Marshall- Pillow Top	73	53	11	24.63	0.698	70	38	16	6	10						14	Hand grinder
42	Lane- Action Comfort Max	79	50	6	13.72	0.389	64	26	10		28						20	HCD machine
43	-	72	52	7	15.17	0.430	48	30	2	4	12						20	HCD machine
44	-	73	50	8	16.90	0.479	56	32	4	10	8						32	HCD machine
45	-	78	74	8	26.72	0.757	66	34	6	4	20						27	HCD machine
46	Sears-o-pedic	80	52	11	26.48	0.750	78	46	10	12	10						43	HCD machine
47	-	71	32	5	6.57	0.186	28	16	2	2	8						22	HCD machine
48	-	68	38	4	5.98	0.169	32	14	4	8	4						25	HCD machine
49	-	75	46	9	17.97	0.509	52	28	2		10	10					18	HCD machine
50	Veraflex	74	52	7	15.59	0.442	46	32	6		6						1	Horizontal Grinder
51	-	74	50	7	14.99	0.425	70	34	6	16		12					1	Horizontal Grinder
52	Sealy- Luxury Firm	76	47	7	14.47	0.410	60	34	8		16						1	Horizontal Grinder
53	Sears- Posture Mate	74	55	7	16.49	0.467	46	28	4	4	6						1	Horizontal Grinder
54	-	72	52	8	17.33	0.491	56	28	4	8	16						1	Horizontal Grinder
55	-	76	46	8	16.19	0.459	54	34	6	4	10						1	Horizontal Grinder
56	-	70	56	5	11.34	0.321	52	18	2		16	14					32	Hand dismantle

57	Springwall- Chiropractic (Qu)	76	54	9	21.38	0.606	66	28	10	4	24					43	Hand dismantle
58	Kingsdown- Kingopedic	76	52	9	20.58	0.583	72	38	14	6	14					50	Hand dismantle
59	-	68	52	4	8.19	0.232	38	18	20							25	Hand dismantle
60	-	74	39	7	11.69	0.331	58	22	14		12	8				35	Hand dismantle
61	Simmons- Caresse Innkeeper	76	54	7	16.63	0.471	60	32	11	4	8					60	Hand dismantle
62	Beverly- Salem	74	38	6	9.76	0.277	36	18	4		14					22	Hand dismantle
63	Springwall- Medic (Qu)	70	58	6	14.10	0.399	46	22	8		16					28	Hand dismantle
64	-	74	53	6	13.62	0.386	88	30	24		16	14				42	Hand dismantle
65	Sealy- Posturpedic Masi	79	76	12	41.69	1.181	90	44	18	16		8	4			21	Hand dismantle
66	Sears- Rest	72	52	7	15.17	0.430	60	28	8		22					24	Hand dismantle
67	-	78	59	8	21.31	0.604	76	42	10	4	18					31	Hand dismantle
68	Hotel Motel- Ther-a-pedic	77	53	8	18.89	0.535	88	38	8	6	12					53	Hand dismantle
69	-	79	59	8	21.58	0.611	68	44	10	6	6					67	Hand dismantle
70	Sears-o-pedic- Prestige	80	59	12	32.78	0.929	88	52	20	12						33	Hand dismantle
71	-	75	53	9	20.70	0.586	56	32	14	4	6					27	Hand dismantle
72	Posture-pedic	75	36	8	12.50	0.354	46	22	6		18					37	Hand dismantle
73	Primo- Dream Collection Silver	74	34	9	13.10	0.371	54	36	10	2	4					22	Hand dismantle
74	Beverly- Springwall	74	36	7	10.79	0.306	54	20	6		12	12				25	Hand dismantle
75	-	72	51	7	14.88	0.421	54	32	8		12					42	Hand dismantle
76	Serta- Supreme I	76	58	7	17.86	0.506	58	30	6	4	16					25	Hand dismantle
77	-	71	57	9	21.08	0.597	62	34	10	8	8					39	Hand dismantle
78	Macgregor (Moncton)	78	51	6	13.81	0.391	48	20	4		18					41	Hand dismantle
79	-	79	50	10	22.86	0.648	80	56	12	10						15	Hand dismantle
80	Simmons- Citadel Inn	72	52	8	17.33	0.491	60	38	4	4	14					29	Hand dismantle
81	-	74	38	4	6.51	0.184	18		2	16						3	Hand dismantle
82	Décor-Rest	73	52	7	15.38	0.436	54	28	2		22					42	Hand dismantle
83	Lane	74	53	7	15.89	0.450	56	26	8		10	10				43	Hand dismantle
84	-	78	50	6	13.54	0.384	30	20	2	4	2					15	Hand dismantle
85	-	82	58	9	24.77	0.702	72	34	12	12	14					28	Hand dismantle
86	Atlantic Sleep Products (Moncton)	71	52	7	14.96	0.424	54	32	6		14					24	Hand dismantle
87	Eaton- Haddon Hall Dreamland	69	38	6	9.10	0.258	38	22	2	12						4	Hand dismantle
88	-	70	39	4	6.32	0.179	22	16	2		4					13	Hand dismantle
89	-	78	76	10	34.31	0.972	82	46	14	6	16					21	Hand dismantle
90	Beverly- Springwall	76	56	8	19.70	0.558	62	32	2		16	10				46	Hand dismantle
91	-	75	52	8	18.06	0.511	56	38	2	6	8					32	Hand dismantle
92	-	73	52	6	13.18	0.373	56	26	2	10	16					24	Hand dismantle
93	-	72	47	9	17.63	0.499	58	32	10	6	8					39	Hand dismantle
94	-	72	38	4	6.33	0.179	26		4	22						6	Hand dismantle
95	Bedding Mattress Co.- Supreme	78	54	7	17.06	0.483	60	38	8	4	10					38	Hand dismantle
96	Sears-o-pedic- Independent Foil	73	52	7	15.38	0.436	54	26	12	2	12					42	Hand dismantle
97	-	77	51	8	18.18	0.515	66	20	8		26	10				20	Hand dismantle
98	-	79	59	6	16.18	0.458	52	30	2		18					35	Hand dismantle
99	Macgregor- Daffodil	74	52	8	17.81	0.505	48	20	2		12	12				26	Hand dismantle
100	Memory Foam	79	78	3	10.70	0.303	44		4							40	5 unzipped
<b>Total</b>		<b>7452</b>	<b>5040</b>	<b>719</b>	<b>1605</b>	<b>45</b>	<b>5510</b>	<b>2770</b>	<b>723</b>	<b>458</b>	<b>1080</b>	<b>168</b>	<b>8</b>	<b>4</b>	<b>84</b>	<b>40</b>	<b>2070</b>
<b># of Mattresses With Component</b>								<b>93</b>	<b>100</b>	<b>60</b>	<b>84</b>	<b>15</b>	<b>1</b>	<b>1</b>	<b>3</b>	<b>1</b>	
<b>Ave Component Weight/# Components</b>							<b>55.10</b>	<b>29.78</b>	<b>7.23</b>	<b>7.63</b>	<b>12.86</b>	<b>11.20</b>	<b>8.00</b>	<b>4.00</b>	<b>28.00</b>	<b>40.00</b>	<b>20.70</b>
<b>Ave Component Weight/ Test Batch Size</b>		<b>74.52</b>	<b>50.40</b>	<b>7.19</b>	<b>16.05</b>	<b>0.45</b>	<b>55.10</b>	<b>27.70</b>	<b>7.23</b>	<b>4.58</b>	<b>10.80</b>	<b>1.68</b>	<b>0.08</b>	<b>0.04</b>	<b>0.84</b>	<b>0.40</b>	<b>20.70</b>
<b>Component % Of Total Weight</b>								<b>50.3%</b>	<b>13.1%</b>	<b>8.3%</b>	<b>19.6%</b>	<b>3.0%</b>	<b>0.1%</b>	<b>0.1%</b>	<b>1.5%</b>	<b>0.7%</b>	



## Table 2

**Table 2**  
**Disassembled Box Spring Data**

	Disassembly Time* (min.)	Method	Total Weight (lbs)	Metal (lbs)	Wood (lbs)	Cover/Padding (lbs)	Cardboard (lbs)
1	24	Hand tools	50	12	32	6	
2	27	Hand tools	58		48	8	2
3	13	Hand tools	42		38	4	
4	15	Hand tools	46		40	6	
5	19	Hand tools	58	24	26	6	
6	21	Hand tools	56		50	4	
7	12	Hand tools	36		28	6	
8	13	Hand tools	42		36	6	
9	26	Hand tools	60	6	48	6	
10	10	Hand tools	28		24	4	
11	15	Hand tools	40		30	8	2
12	12	Hand tools	46		40	6	
13	18	Hand Grinder	50	4	38	8	
14	15	Hand Grinder	44		30	10	2
15	20	Hand Grinder	62	30	22	8	
16	23	Hand Grinder	52		40	12	
17	11	Hand Grinder	34		26	6	2
18	1	Grinder	48				
19	1	Grinder	36				
20	1	Grinder	46				
<b>Total</b>	<b>297</b>		<b>934</b>	<b>76</b>	<b>596</b>	<b>114</b>	<b>8</b>
<b># Of Box Springs With Component</b>				<b>6</b>	<b>17</b>	<b>17</b>	<b>4</b>
<b>Ave Component Weight/# Components</b>				<b>12.67</b>	<b>35.06</b>	<b>6.71</b>	<b>2.00</b>
<b>Ave Component Weight/ Test Batch Size</b>	<b>14.85</b>		<b>46.70</b>	<b>3.80</b>	<b>29.80</b>	<b>5.70</b>	<b>0.40</b>
<b>Component % Of Total Weight</b>				<b>8.1%</b>	<b>63.8%</b>	<b>12.2%</b>	<b>0.9%</b>

**Notes:**

\*Did not separate components before putting them into the horizontal grinder.

**Table 3****Disposal Fee Required Using MattCanada Equipment**

	Year 20X1: Nova Scotia	Year 20X1: Halifax
<b>Estimated Discarded Mattresses</b>	77,243 /yr	31,637 /yr
<b>Disposal Fee/Unit</b>	\$ 6.69	\$ 13.89
<b>REVENUE</b>		
Disposal Fee/ Unit	\$ 516,640.14 /yr	\$ 439,416.14 /yr
Material revenue (note 1)	\$ 73,725.00 /yr	\$ 30,199.00 /yr
<b>TOTAL REVENUE</b>	\$ 590,365.14 /yr	\$ 469,615.14 /yr
<b>GENERAL &amp; ADMINISTRATION EXPENSES</b>		
Administration	\$ 45,000.00 /yr	\$ 45,000.00 /yr
Sales & marketing	\$ 30,000.00 /yr	\$ 30,000.00 /yr
Insurance	\$ 40,000.00 /yr	\$ 40,000.00 /yr
Site manager	\$ 45,000.00 /yr	\$ 45,000.00 /yr
Labour wages (note 2)	\$ 140,000.00 /yr	\$ 70,000.00 /yr
Forklift lease	\$ 14,500.00 /yr	\$ 14,500.00 /yr
Building lease (note 3)	\$ 60,000.00 /yr	\$ 36,000.00 /yr
Supplies & consumables	\$ 10,000.00 /yr	\$ 10,000.00 /yr
Equipment maintenance & repairs	\$ 15,000.00 /yr	\$ 15,000.00 /yr
Miscellaneous & contingency	\$ 40,000.00 /yr	\$ 30,000.00 /yr
Electricity	\$ 42,000.00 /yr	\$ 31,000.00 /yr
Landfill Disposal Fee (note 4)	\$ 13,500.00 /yr	\$ 7,750.00 /yr
Utilities and office expenses	\$ 15,000.00 /yr	\$ 15,000.00 /yr
Professional fees & banking	\$ 20,000.00 /yr	\$ 20,000.00 /yr
Research & development provision	\$ 10,000.00 /yr	\$ 10,000.00 /yr
<b>TOTAL GENERAL &amp; ADMINISTRATION EXPENSES</b>	\$ 540,000.00 /yr	\$ 419,250.00 /yr
<b>EBITDA</b>	\$ 50,365.14 /yr	\$ 50,365.14 /yr
<b>DEBT SERVICING</b>		
Loan principle repayment & interest (note 5)	\$ 50,365.14 /yr	\$ 50,365.14 /yr
<b>NET CASHFLOW BEFORE INCOME TAXES</b>	\$ 0.00 /yr	\$ 0.00 /yr

Note 1: Mattresses \* 28 pounds / 2200 pounds=Tonnes of recoverable steel @ \$75/tonne

Note 2: Labours @ \$35,000/each/year

Note 3: Ten year lease in a 5000/3000 sq. ft. building at \$12.00/sq. ft./year

Note 4: 100/50 tonnes of unrecyclable material @ \$115/tonne tipping fee + \$2,000 for transportation

Note 5: Total Capital Costs \$332,600 (Mattress dismantler- \$223,850; Box spring dismantler- \$68,750; Baler- \$40,000)

@ 6% interest rate, depreciated over 7 years

**Table 4****Disposal Fee Required When Hand Dismantling**

	Year 20X1: Nova Scotia	Year 20X1: Halifax
<b>Estimated Discarded Mattresses</b>	77,243 /yr	31,637 /yr
<b>Disposal Fee/Unit</b>	\$ 10.62	\$ 16.19
<b>REVENUE</b>		
Disposal Fee/ Unit	\$ 820,582.14 /yr	\$ 512,233.14 /yr
Material revenue (note 1&6)	\$ 73,725.00 /yr	\$ 30,199.00 /yr
<b>TOTAL REVENUE</b>	\$ 894,307.14 /yr	\$ 542,432.14 /yr
<b>GENERAL &amp; ADMINISTRATION EXPENSES</b>		
Administration	\$ 45,000.00 /yr	\$ 45,000.00 /yr
Sales & marketing	\$ 30,000.00 /yr	\$ 30,000.00 /yr
Insurance	\$ 40,000.00 /yr	\$ 40,000.00 /yr
Site manager	\$ 45,000.00 /yr	\$ 45,000.00 /yr
Labour wages (note 2)	\$ 525,000.00 /yr	\$ 210,000.00 /yr
Forklift lease	\$ 14,500.00 /yr	\$ 14,500.00 /yr
Building lease (note 3)	\$ 60,000.00 /yr	\$ 36,000.00 /yr
Supplies & consumables	\$ 10,000.00 /yr	\$ 10,000.00 /yr
Equipment maintenance & repairs	\$ 15,000.00 /yr	\$ 15,000.00 /yr
Miscellaneous & contingency	\$ 40,000.00 /yr	\$ 30,000.00 /yr
Electricity	\$ 12,000.00 /yr	\$ 12,000.00 /yr
Landfill Disposal Fee (note 4)	\$ 6,750.00 /yr	\$ 3,875.00 /yr
Utilites and office expenses	\$ 15,000.00 /yr	\$ 15,000.00 /yr
Professional fees & banking	\$ 20,000.00 /yr	\$ 20,000.00 /yr
Research & development provision	\$ 10,000.00 /yr	\$ 10,000.00 /yr
<b>TOTAL GENERAL &amp; ADMINISTRATION EXPENSES</b>	\$ 888,250.00 /yr	\$ 536,375.00 /yr
<b>EBITDA</b>	\$ 6,057.14 /yr	\$ 6,057.14 /yr
<b>DEBT SERVICING</b>		
Loan principle repayment & interest (note 5)	\$ 6,057.14 /yr	\$ 6,057.14 /yr
<b>NET CASHFLOW BEFORE INCOME TAXES</b>	\$ 0.00 /yr	\$ 0.00 /yr

Note 1: Mattresses \* 28 pounds / 2200 pounds=Tonnes of recoverable steel @ \$75/tonne

Note 2: Labours @ \$35,000/each/year 7 Hours/day\*250 days=1750 hours/man\*3 mattress/hour=5250 mattresses/person

Note 3: Ten year lease in a 5000/3000 sq. ft. building at \$12.00/sq. ft./year

Note 4: 50/25 tonnes of unrecyclable material @ \$115/tonne tipping fee + \$1,000 for transportation

Note 5: Total Capital Costs \$40,000 (Baler) @ 6% interest rate, depreciated over 7 years

Note 6: May not have markets for dismantled materials except metal