Dalhousie Green Labs: Increasing Solid Waste Diversion in Dalhousie Laboratories

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Acknowledgments

- Resource Recovery Fund Board for contributing funding to the Dalhousie Green Labs project.
- Rochelle Owen, Director of the Office of Sustainability, for offering guidance and mentorship throughout the project.
- Dr. Peter Duinker for acting as my academic advisor for this project.
- Dalhousie custodial and grounds staff for contributing suggestions and feedback in focus groups and meetings.
- Dalhousie Environmental Health and Safety for providing guidance on recycling procedures.
- Dalhousie lab users for participating in interviews, meetings, and focus groups.

Support for this project was provided in part by the Nova Scotia Resource Recovery Fund Board

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Abstract

The province of Nova Scotia is internationally recognized as a leader in solid waste management. With the introduction of the "Solid Waste Resource Management Strategy", the Province committed to various initiatives to enhance solid waste diversion from landfills. Through legislation, Nova Scotia has established a goal for each resident to contribute no more than 300 kilograms of waste to the landfill per year by 2015. In addition to reducing the consumption of cell space, sparing materials from the landfill limits the environmental burden associated with the degradation of products.

Dalhousie University has also established aggressive diversion targets. The University has committed to a solid waste diversion rate of 70% by 2020; currently Dalhousie diverts approximately 60% of the waste produced on campus. Laboratories are an area of challenge due to the generation of complicated waste streams. Previous research conducted by Dalhousie students has indicated that recyclable materials are often added to the lab garbage stream; therefore, presenting an opportunity for diversion. The Dalhousie Green Labs project identified the types of waste generated within the lab, discovered barriers to recycling and composting, and used this information to develop effective disposal procedures. In the completion of the project, literature was reviewed and interviews, meetings and focus groups were conducted. Research indicated that plastic, glass, paper towel, Styrofoam, and disposable gloves are the most prevalent types of waste to contribute to the lab garbage stream. Barriers to recycling and composting were also identified; a lack of disposal knowledge was cited as the most prominent barrier. As a result of the research conducted, recycling/composting streams will be introduced for lab plastic, glass and paper towel, and a Styrofoam recycling pilot has been scheduled. To address the lack of disposal knowledge, the Dalhousie Waste Guide (which includes an appendage titled the Empty Hazardous Material Container Recycling Procedures) has been developed and lab-specific bin signage will be displayed in the lab to educate users on appropriate disposal behaviour. It is anticipated that the introduction of new recycling and composting streams in labs will significantly contribute to the achievement of the University's solid waste diversion target.

1.0 Introduction

Dalhousie has established an aggressive solid waste diversion target of 70% (Dalhousie Office of Sustainability, 2010). Although the University has progressed toward this goal, laboratories continue to experience diversion challenges and contribute significantly to the garbage stream. The generation of complex waste streams in labs contributes to the challenge of recycling and composting. As a diverse array of waste exists within the lab, it is essential that lab users are provided with adequate guidance to ensure the accurate and safe disposal of solid waste.

The objectives of the Dalhousie Green Labs project were to develop an understanding of the types of materials contributing to the lab waste stream, prepare an educational guide to explain appropriate waste disposal within the lab, standardize laboratory bin and signage requirements, and develop disposal procedures to recycle/compost materials commonly generated in the lab. This report will elaborate on solid waste management at Dalhousie, provide results from primary and secondary data collection, introduce several prominent types of waste that contribute to the garbage stream and explain the risks associated with landfilling these materials, suggest ways in which material streams can be diverted from the landfill through recycling or composting, and introduce the Dalhousie Waste Guide, lab-specific bin signage and lab bin standards.

2.0 Background

2.1 Solid Waste Management in Nova Scotia

In 1995 the province of Nova Scotia introduced the “Solid Waste Resource Management Strategy”. The strategy prompted the Province to reduce the quantity of solid waste sent to provincial landfills. Through a commitment to various initiatives, the Province has taken great stride toward a more sustainable future and Nova Scotia has become internationally recognized for its solid waste diversion achievements. Through the *Environment Act* (2006) and the *Environmental Goals and Sustainable Prosperity Act* (2007), Nova Scotia has committed to having each resident contribute no more than 300 kilograms of waste to the garbage stream per year by 2015 (Nova Scotia Environment, 2014). Despite progress, there continues to be opportunity for improvement. Stantec Consulting Limited (2009) identified that up to 50% of

'institutional commercial industrial' (ICI) materials transported to the Halifax Regional Municipality (HRM) landfill could be diverted through recycling or composting.

2.2 Solid Waste Management at Dalhousie University

Dalhousie University has set aggressive targets for solid waste management paralleling the "Solid Waste Resource Management Strategy". Dalhousie has committed to a diversion target of 70% for solid waste produced at the four University campuses. Through research and the implementation of various strategies, the University successfully diverts over 60% of solid waste (Brady & Jorgensen, 2011). Dalhousie staff and student body participation has contributed to the achievement of increased diversion; however, additional opportunities exist. Dalhousie laboratories lack an effective diversion program and amendments to the solid waste management procedures in labs could further the University's progress toward 70% solid waste diversion.

2.3 Solid Waste Management in Dalhousie Laboratories

Halifax campus research spaces include 2,455 labs facilitating research requirements for various departments (Brady & Jorgensen, 2011). Dalhousie laboratories discard large amounts of glass, plastic, and paper towel into refuse bins, some of which could be diverted from the landfill by recycling or composting (Biagi, Ciurlia, McCarthy, Penwarden & St. Louis, 2011). Laboratory waste is comprised of various materials, both hazardous and non-hazardous. Many empty chemical containers are safe to recycle; however, certain precautions must be taken to ensure the safety of the laboratory personnel, custodial staff, and all other individuals that may come in contact with the recycled materials. Precautionary standards must be developed, documented, and practiced. It is imperative that all laboratory users follow the established protocol not only to ensure safety, but also to instill confidence and comfort in custodial staff to ensure recyclable materials are collected in a uniform manner.

Issues have been identified regarding recycling in Dalhousie laboratories; there is inconsistency in the bins available in each lab, limited accessibility to recycling bins, and an inadequate understanding of the proper disposal procedures for recyclable materials (Ummat, 2013). In a study conducted by Brady and Jorgensen (2011), 120 Dalhousie labs were assessed.

It was discovered that many of the labs did not have recycling bins; as a result, paper and plastic waste was mixed with refuse in garbage bins. The study identified differing procedures for storing empty glass containers; some lab users stored empty containers in a 'broken glass box', and others stored containers in unofficial cardboard boxes anticipating collection by custodial staff. In many cases, there was uncertainty surrounding the original contents of the bottles. Discrepancies in the technique for defacing the empty containers imposed uncertainty regarding appropriate handling and disposal procedures. The study demonstrated an apparent inconsistency in disposal practices and highlighted a need for a standardized approach to disposing of laboratory solid waste.

2.4 Importance of the Study

The Dalhousie Green Labs project enabled the preparation of the Dalhousie Waste Guide, lab-specific bin signage, and laboratory bin standards. The documents will encourage solid waste recycling and enhance the disposal knowledge of lab users. Research also facilitated the introduction of new recycling procedures for several waste streams. The guide, signage, bin standards, and implementation of recycling procedures will contribute to the consistent and safe disposal of laboratory solid waste while simultaneously enhancing the diversion of laboratory solid waste from landfills.

3.0 Objectives

1. Develop an understanding of the waste streams generated in Dalhousie laboratories.

To prepare the Dalhousie Waste Guide, it was vital to understand the waste streams generated in Dalhousie labs. Dalhousie laboratory visits provided an opportunity to identify the types of waste generated and the disposal procedures practiced.

2. Preparation of the Dalhousie Waste Guide.

Education and raising awareness are crucial to encouraging recycling (Timlett & Williams, 2007). This is especially important given the large number of Dalhousie students that come from other locations that may be unfamiliar with local solid waste disposal systems (Ummat,

2013). There are a variety of means to educate individuals on efficient recycling behaviour; the Dalhousie Green Labs project has provided educational material in the form of the Dalhousie Waste Guide and bin signage designed specifically for use in labs.

3. Develop laboratory bin standards.

An understanding of the factors inhibiting recycling was necessary to recommend bin standards. Physical barriers to recycling can deter individuals from recycling solid waste (Tonglet, Phillips & Read, 2003), and the accessibility of recycling bins can impact the likeliness that an individual will divert recyclables from the garbage stream (Gonzalez-Torro & Adenso-Diaz, 2004). It has been suggested that physical characteristics such as container size and colour can influence recycling rates (Lane & Wager, 2013). Laboratory visits identified the bin systems used in labs throughout Dalhousie and highlighted barriers to recycling. The information gathered was used to recommend bin standards to encourage solid waste diversion.

4. Identify recycling opportunities and develop procedures for the collection, transportation, and disposal of each stream.

Research included meetings with custodial staff and lab users to identify the most common waste materials generated in the lab, and effective systems to sort, collect, transport and dispose of waste.

4.0 Methods

Qualitative and quantitative research methodology was employed for the Dalhousie Green Labs project. An analysis of previous studies conducted by Dalhousie University emphasized the need for additional research into laboratory solid waste diversion and highlighted some of the challenges associated with solid waste management in Dalhousie labs. Subsequent literature review provided insight into the history of waste management in Nova Scotia and presented some of the risks associated with landfilling several types of waste commonly generated in the lab setting. Additional information was gathered through interviews, lab visits, and focus groups with laboratory stakeholders and custodial staff.

4.1 Literature Review

Existing Dalhousie data was examined, research and laboratory waste protocol used at other Canadian universities has been studied, and academic journals and government websites were analyzed.

4.2 Lab Visits, Interviews, and Meetings

Various labs were visited to provide firsthand examples of the solid waste generation and management within the lab. Interviews and meetings were held with a variety of stakeholders, including Dalhousie Environmental Health and Safety, Office of Sustainability and Facilities Management staff, Dalhousie lab users, and Municipal government representatives.

4.3 Focus Groups

Focus groups can be used to develop an understanding of participant knowledge and can offer examples of experiences as they relate to the research being conducted. It can be of particular use to understand what participants think, in addition to why they think in such a way (Kitzinger, 1995). Focus groups with laboratory users were held to gather feedback regarding current solid waste streams and to develop an understanding of the variation in solid waste disposal practices in Dalhousie laboratories. Focus groups provided the opportunity to gather feedback in the preparation of the Dalhousie Waste Guide, laboratory bin standards, lab-specific bin signage, and solid waste recycling and composting procedures.

4.4 Ethics Application

An ethics application was submitted and approved for the Dalhousie Green Labs project (see Appendix A – D).

5.0 Results

Throughout the duration of the Dalhousie Green Labs project 33 individuals were engaged through meetings, lab visits, interviews, and focus groups. Research participants from the Halifax and Bible Hill campuses represented the interests of Dalhousie Facilities Management,

Environmental Health and Safety, and lab users spanning several departments including chemistry, biology, medicine, dentistry, and engineering. Contributions were also made by individuals external to Dalhousie; HRM and Colchester County Municipal representatives, staff from several Canadian universities, and local businesses (e.g. construction/demolition contractors) provided guidance to enhance solid waste diversion.

5.1 Laboratory Visits, Interviews, and Meetings

Laboratory visits and interviews were held between July 4th, 2014 and September 23rd, 2014. Lab visits were conducted to develop a thorough understanding of waste management in the lab setting and to provide firsthand examples of the most commonly occurring types of waste materials. Interviews with lab stakeholders provided a means to collect insights, concerns, and feedback regarding solid waste management in labs.

5.1.1 Waste Materials Commonly Placed in the Garbage Stream

Laboratory visits and interviews indicated that the largest contributors to the garbage stream include disposable sanitary cloths (e.g. Kimwipes™), disposable gloves, paper towel, glass, and plastic. Additionally, lab users in the biology and medical departments highlighted an abundance of Styrofoam™ in the garbage stream.

5.1.2 Reuse and Recycling Opportunities

A desire to recycle lab glass and plastic was presented in a number of lab visits and interviews. In addition, various lab users stated that paper towel contributes immensely to the garbage stream in their lab and expressed an interest in composting clean paper towel. Several individuals from the Chemistry building, Sir Charles Tupper Medical building, and the Life Sciences Centre stated that they currently clean specific chemical containers for refill from Chemical Stores and suggested this system could work for other buildings as well.

Discussions with the Dalhousie Environmental Health and Safety Office were held regarding plastic and glass chemical container recycling (see section 6.1 for additional details on plastic recycling and section 6.2 for additional details on glass recycling). It was identified that

recycling procedures must be in compliance with the recycling facility that will process the materials. In regards to recycling lab plastic and glass, a Dalhousie Environmental Health and Safety Office representative stated the following:

> For the safety of those collecting and recycling the glass, it is important to ensure that laboratory glassware is cleaned appropriately prior to disposal for recycling. Chemically contaminated lab-ware [glassware and plastics] should be triple-rinsed and/or decontaminated. If laboratory personnel determine that the rinse from the cleaning the lab-ware is hazardous, it should be collected, packaged and labeled as a chemical waste (S. Beaton, personal communication, Dec. 2nd, 2014).

It was also stated that only glass containers that held acids, solvents, or bases should be recycled. It is imperative that the materials are clean and dry with the label defaced prior to being added to the recycling stream. The necessity of triple-cleaning and defacing the label of empty chemical bottles and ensuring the cleanliness of all other lab material destined for recycling was emphasized; additionally, lab users should be encouraged to write 'rinsed bottle' on the label (S. Beaton, personal communication, August 19th, 2014). The cleanliness of recycled materials is a requirement that is shared by recycling facilities.

5.1.3 Barriers to Recycling

It was indicated that laboratory managers are responsible for purchasing bins; therefore, participation in recycling is voluntary and each lab has a unique solid waste management system. Evidently, standardization is lacking in laboratories across Dalhousie (Figure 1).

A lack of knowledge, communication, and/or care was cited as one of the main barriers to recycling. Students attend Dalhousie from around the globe and preexisting recycling behavior along with language barriers have contributed to waste stream contamination. Paper towel contributes heavily to the garbage stream; however, theoretically clean paper towel (used to wipe up water or dry wet hands) can be spared from the landfill if deposited in the organics stream. There was hesitation to introduce bins to accommodate paper towel composting as research participants feared chemically contaminated paper towel may enter the stream due to a lack of care or understanding from lab users. A limited understanding and

confidence in lab solid waste procedures has left custodial staff uncomfortable collecting some materials from the lab. Custodial staff voiced concerns stemming from the collection of innocuous laboratory waste that has a threatening appearance. Pipettes have been quoted as a waste item that theoretically could be recycled, but the hazardous appearance has incited concern within the custodial team during collection.

The inconvenience of transporting waste to recycling bins was identified as a barrier to recycling, this would suggest that waste bins must be available within close proximity to work spaces; however, a lack of space in laboratories was also recognized as a barrier. Lab users described a fast-paced work environment in which time is of the essence. An experiment often cannot be interrupted to walk to communal recycling bins, rather, each work station is equipped with a garbage bin in which nearly all waste is discarded.

Figure 1: Variation in Dalhousie lab waste bins

(Photos by S. Miller)

5.2 Focus Groups

Participants from two focus groups have contributed information to the Dalhousie Green Labs project. The first focus group was held on August 6th, 2014 and was attended by six Dalhousie employees from Halifax and Bible Hill that represented the interests of lab users and custodial staff. The focus group addressed questions arising from preceding lab visits and interviews, identified areas of concern regarding solid waste management in the lab, and requested feedback on recycling opportunities. The information gathered from the focus group was used to finalize the first draft of the Dalhousie Waste Guide and to establish draft bin standards for

Dalhousie labs. A subsequent focus group was held on September 15th, 2014, eight individuals participated representing the interests of the Dalhousie Environmental Health and Safety Office, lab users, building managers, and custodial staff. Focus group participants were asked for final recommendations to assist in the completion of the Dalhousie Waste Guide and the laboratory bin standards. Additionally, participants offered insights into the implementation of several additional recycling streams.

5.2.1 Waste Materials Commonly Placed in the Garbage Stream

In reference to the materials most commonly added to the garbage stream, focus group participants reiterated comments from previous lab visits and interviews. They identified a majority presence of disposable sanitary cloths (e.g. Kimwipes™), disposable gloves, paper towel, glass, plastic, and Styrofoam™ in the garbage stream.

Dalhousie University has implemented various policies to ensure safety in laboratories. School policies enforce the use of lab safety gear including lab aprons, goggles, and gloves. Although goggles can be reused, disposable aprons and gloves are discarded following use. Focus group participants indicated that copious amounts of disposable gloves are added to the garbage stream.

5.2.2 Reuse and Recycling Opportunities

Only some Dalhousie labs are equipped with automatic paper towel dispensers and it was stated that manual dispensers result in excessive waste. It was suggested that automatic dispensers could reduce the consumption of paper towel.

The "Dalhousie Policy for Personal Protective Equipment" states that lab coats are not permitted in areas outside of the lab and that home laundering of lab coats is also prohibited (Dalhousie University Environmental Health & Safety Office, 2013). As such, many lab users opt for the use of disposable aprons which a representative from HRM Solid Waste Resources indicated are not suitable for recycling (M. Maessen, personal communication, August 11th, 2014). Focus group participants suggested the initiation of an in-house laundering service to enable the washing and reuse of lab coats.

There was a discussion regarding the current centralized distribution of chemicals in the Chemistry and Sir Charles Tupper Medical buildings. Both buildings purchase large drums of commonly used chemicals to refill small glass jugs used within the lab. Aside from in the chemistry and medical buildings, most lab users order chemicals on an individual basis and discard the containers once empty.

Three focus group participants expressed concern regarding the large amount of Styrofoam™ transferred to the landfill. It was highlighted that due to the lightweight nature of this material, removing it from the garbage stream would not substantially reduce the weight of solid waste entering the landfill; however, it would reduce the volume.

The large quantity of glass generated in laboratories was discussed in both focus groups. Discussions regarding optimal procedures for glass recycling identified risks associated with the collection of broken glass. It was suggested that Dalhousie implement glass recycling incrementally, starting with recycling empty chemical bottles and containers.

5.2.3 Barriers to Recycling

Barriers to recycling expressed by focus group participants echoed discussions in previous lab visits and interviews. The main hesitation to providing recycling bins in the lab is the lack of knowledge and/or care of lab users. The introduction of recycling streams ultimately entrusts lab users to appropriately discard materials. Simply stating that materials added to the recycling streams must be ‘benign’ or ‘clean’ does not suffice; clear protocol is required to ensure that only suitable and safe materials are collected for recycling.

6.0 Goals for Laboratory Solid Waste Diversion

Lab visits, interviews, and focus groups identified a number of opportunities to increase the diversion of solid waste from landfills. Upon identifying the main materials that contribute to the garbage stream, follow-up research was completed to suggest recycling opportunities for several waste streams. Recycling/composting opportunities exist for plastic, glass, Styrofoam™, and paper towel. Additional research should be conducted to identify opportunities to reduce the

amount of waste generated through the use of disposable lab aprons, gloves, and sanitary cloths (Table 1).

Table 1: Short-term and long-term goals for lab waste materials

	Short-term	Long-term
Lab plastics	• Wash and reuse plastic lab equipment. • Implement a plastic container and packaging recycling program in labs.	• Reduce plastic waste by purchasing glass chemical bottles that can be cleaned and refilled. • Reduce plastic waste by purchasing glass lab equipment that can be washed and reused. • Implement recycling procedures for all plastic lab equipment that can be properly cleaned.
Lab glass	• Wash and reuse glass lab equipment. • Implement a glass bottles and containers recycling program in labs.	• Establish chemical distribution services in all buildings with labs (currently, only the Chemical building and Sir Charles Tupper Medical building distribute chemicals). • Implement recycling procedures for outdated/unused glass lab equipment.
Lab Styrofoam™	• Reuse Styrofoam™ coolers in lab experiments. • Establish a partnership to recycle all Styrofoam™ generated on Halifax campuses through Truefoam Ltd.	• Consider suppliers that use limited Styrofoam™ for packaging. • Research Styrofoam™ recycling opportunities for the Bible Hill Campus.
Paper towel	• Use a washable cloth (if safe to do so). • Implement a composting program in labs.	• Install automated paper towel dispensers in each lab. • Research paper towel alternatives to determine the most environmentally benign option with the smallest footprint in the landfill.
Disposable lab aprons	N/A	• Organize an in-house laundering service to wash and reuse lab coats.
Disposable gloves	N/A	• Research disposable glove alternatives to determine the smallest footprint in the landfill.
Disposable sanitary cloths (e.g. Kimwipes™)	• Use a washable cloth (if safe to do so).	• Research disposable cloth alternatives to determine the smallest footprint in the landfill.

6.1 Plastic Recycling

6.1.1 Plastic in the Waste Stream

245 million tons of plastic are produced each year (Andrady, 2011). Given its strength, flexibility, affordability, durability, and light-weight nature, it has displaced the use of many other materials (Shah, Hasan, Hameed & Ahmed, 2008; Sivan, 2011). Each year the production of plastic increases by approximately 25% (Jayasekara, Harding, Bowater & Lonergan, 2005) with nearly one-third of all production allocated to the generation of plastic packaging (Andrady, 2011).

Most plastics are manufactured using oil, coal, or natural gas and are not biodegradable (Shah et al., 2008); however, a small percentage of plastic is produced to biodegrade (Jayasekara et al., 2005). Once landfilled non-biodegradable plastics are typically exposed to ultraviolet light resulting in photo-oxidization causing the plastic to become brittle and eventually break into microplastics. Microplastics can seep into water systems with devastating implications for terrestrial and marine life (Sivan, 2011). Microplastics are approximately the same size as phytoplankton and often mistakenly ingested by small sea creatures (Andrady, 2011) which inevitably are eaten by organisms in higher trophic levels. Sivan (2011) stated that "[w]ithin just a few decades, since mass production of plastic products has initiated, plastic debris has accumulated in terrestrial and marine environments... ingested plastic debris is likely to penetrate and accumulate in the food chain, exerting multiple hazards that their outcome still have to be elucidated" (p. 422).

Plastic is capable of absorbing contaminants from the environment and can pass these toxins to organisms through inhalation, dermal absorption, or ingestion (Teuten et al., 2009). Of serious concern is the absorption of persistent organic pollutants which impose a series of health risks through the discharge of carcinogens and endocrine disruptors (Frias, Sobral & Ferreira, 2010).

6.1.2 Plastic Recycling Opportunity in Dalhousie Labs

Focus groups, lab visits, and interviews articulated an abundance of plastic generated in the laboratory environment. A meeting was held with an HRM Solid Waste Resources representative to confirm the recyclability of lab plastics. It was determined that if clean, all lab plastic can be added to the existing 'recyclables' stream aside from disposable gloves, aprons, and bench covers (M. Maessen, personal communication, August 11th, 2014). The Colchester County Materials Recycling Facility (MRF) has also agreed to accept clean plastic in the 'recyclables' stream (D. Proctor, personal communication, Nov. 26th, 2014).

Focus group participants demonstrated support for recycling clean plastic containers, but raised concerns associated with recycling plastic lab equipment. Hesitation stemmed from the possible contamination of hard-to-clean plastic equipment such as tubing and pipette tips.

6.1.2.1 Plastic Recycling Recommendations

It is recommended that Dalhousie University initiate plastic recycling procedures for campus labs. In light of the concerns identified by focus group participants, it is suggested that recycling efforts should focus on clean plastic containers and plastic packaging. The plastic should be collected in the lab within a small bin marked 'Lab Recyclables' (see section 8.2 for additional information pertaining to lab bin signage), once full it should be emptied into the 'recyclables' bin in the hallway for regular collection. Research participants voiced concern regarding the inconvenience of recycling while conducting time-sensitive experiments; however, this applies to lab equipment and recycling plastic containers and packaging should not pose any issues in this regard. Recycling plastic lab equipment (e.g. tubing and petri dishes) adds complication due to difficult cleaning requirements; therefore, to further reduce waste, the use of hard-to-clean plastic equipment should be reduced as much as possible.

6.2 Glass Recycling

6.2.1 Glass in the Waste Stream

In theory, glass can be recycled indefinitely; however, it is often landfilled primarily due to inconsistencies in the glass stream (Sobolev, Türker, Soboleva & Iscioglu, 2006). Glass has been in use for more than 9,000 years (Sobolev et al., 2006), and in 2012 alone, the United States contributed approximately 11.6 million tons of glass to municipal solid waste streams (EPA, 2014). It has been estimated that it will take approximately one million years for a single glass bottle to breakdown in a landfill (EPA, 2013). Given the longevity of this material and its high demand, disposal alternatives should be considered to prevent it from entering the landfill. Many forms of waste glass can be used as cullet in new glass production; alternatively, it can be used as an additive or substitute for several construction materials including fiberglass, aggregate, concrete, reflective paint, backfill, or glass powder that can be used in lubricants (Chen et al., 2002). Halifax C & D uses waste glass in the production of cold mix asphalt (D. Chassie, personal communication, August 19th, 2014). When considering the energy consumed in the production of traditional construction aggregate, Morris (1996) states that substituting glass can save approximately 600 kilojoules of energy per kilogram of aggregate. Ismail and Al-Hashmi (2008) conducted a study to determine the effect of using waste glass in the production of concrete. They assessed various properties of the concrete, such as workability and expansion, and determined that using glass in the production process can positively influence the quality of concrete. As such, preventing glass from being landfilled not only reduces the environmental burden, it also proves advantageous for use in construction.

6.2.2 Laboratory Glass Recycling Procedures in Other Canadian Universities

22 Canadian post-secondary educational institutions were contacted to discuss lab glass recycling initiatives; conversations were held with representatives from 16 schools. Ten of the schools do not have a procedure in place for recycling lab glass, one school has recently implemented a pilot to determine quantities of glass generated within the lab setting, and five institutions currently collect and recycle lab glass. The following universities provided details

pertaining to their lab glass recycling procedures: University of Victoria, University of Alberta, University of Toronto, Laval University, and University of Ottawa. Each school has implemented unique procedures for lab glass recycling (Appendix E). The procedures used by other schools have been assessed in determining the optimal glass recycling program for Dalhousie.

6.2.3 Glass Recycling Opportunity in Dalhousie Labs

Waste glass can be used in the creation of various materials, markets for the following post-consumer glass products exist in Nova Scotia: sandblast material, wastewater filtration (for septic beds), roadbed aggregate, landfill cover, landscaping and outdoor esthetics (gardens, walkways, etc.), sand/salt mix for icy roads, and containers (SNC-Lavalin Inc., 2006). Sparing glass from the landfill has various environmental benefits, but it also has economic advantages for the University. Lab glass is currently included in the garbage stream and the University waste hauler charges a fixed pick-up fee as well as a variable fee imposed based on the weight of garbage (R. Owen, personal communication, June 5th, 2014). Although the exact quantity of lab glass included in the University's waste stream has not been formally determined, feedback gathered from lab visits, interviews, and focus groups has indicated that glass is a large contributor to laboratory waste; therefore, removing this material from the garbage stream would reduce the weight charges imposed by the hauler.

6.2.3.1 Glass Disposal Procedures

A number of factors were evaluated in determining the optimal glass recycling procedures for Dalhousie University. Discussions regarding glass recycling were held with several recycling facilities. Halifax C & D agreed to accept all clean glass, including lab glassware (e.g. beakers and test tubes), and broken glass for a cost of $75/ton (D. Chassie, personal communication, August 19th, 2014), and the Halifax MRF agreed to accept all clean glass containers, but not lab glassware, as part of the regular 'recyclables' stream (S. Dillman, personal communication, November 24th, 2014). The Colchester County MRF will also accept clean glass bottles and containers as part of the 'recyclables' stream (J. McFarlane, personal communication, Nov. 27th, 2014).

Focus groups and interviews identified potential risk associated with recycling broken glass; as such, participants suggested that glass recycling should be introduced incrementally, with the first stage encouraging the recycling of empty glass containers and bottles. Additionally, participants identified concerns regarding limited space within the lab. If space is constrained, given the size of the glass chemical containers commonly used (a large number of chemicals are purchased in four litre jugs), rather than collecting empty glass bottles within the lab, the empty containers and bottles should be triple-cleaned, the label defaced, and once dry, taken to the nearest hallway bin set and careful placed inside the 'recyclables' bin. However, if space permits, the containers may be collected within the lab 'recyclables' bin which is emptied into the hallway 'recyclables' bin once full. The hallway bins are lined with bags, and once full, custodial staff removes the bag from the bin, places it in a collection cart and transports it to the loading dock where the contents is added to the 'recyclables' stream, and eventually transported to the recycling facility.

6.2.3.2 Glass Recycling Recommendations

It is recommended that Dalhousie initiate glass bottle and container recycling university-wide using the procedures presented above. To reduce glass waste further in the future, expanding lab glass recycling to include lab glassware (e.g. beakers and test tubes) and broken glass should be considered.

Theoretically, broken glass and unused glass lab equipment can be recycled from Halifax campuses; for this to occur, the glass would need to be transported to Halifax C & D as the Halifax MRF will only accept glass containers and bottles. Transporting glass to Halifax C & D would require the development of new collection, storage, and transportation procedures, and would incur an additional tipping fee of $75/ton. If glass lab equipment is to be collected, a convenient collection system will need to be introduced to ensure recycling does not disrupt time-sensitive experiments. Glass would need to be collected separately from the 'recyclables' stream; therefore, a new storage mechanism would need to be determined. John Ross & Sons Ltd. agreed to provide a large, covered, and lockable dumpster to collect glass on-campus. They would pick-up the full dumpster and empty it at Halifax C & D on an on-call basis. They would charge $120 to empty the dumpster, plus

the $75/ton tipping fee imposed by Halifax C & D (G. Lane, personal communication, Jan. 14th, 2015). Additionally, due to the weight of glass, an automatic tipper would be required to tip the contents of the bin into the dumpster.

6.3 Styrofoam™ Recycling

6.3.1 Expanded Polystyrene in the Waste Stream

Expanded polystyrene (EPS) is often referred to as Styrofoam™; however, in reality, Styrofoam™ is the brand name for EPS manufactured by the Dow Chemical Company. EPS is a petroleum-based product that is typically manufactured for one-time-use (Suwanmanee, et al., 2012). The generation, use, and subsequent disposal of EPS products inevitably contribute to greenhouse gas, acidification, and the creation of smog (Zabaniotou & Kassidi, 2003). Additionally, there are health concerns associated with the degradation of EPS. Styrene is manufactured using benzene and ethylene monomers, then polymerized to create polystyrene (Uihlein, Ehrenberger & Schebek, 2007). The degradation of polystyrene into styrene and benzene is concerning; benzene has been identified as a carcinogen (Duarte-Davidson, Courage, Rushton & Levy, 2001), and styrene is considered a neurotoxin and carcinogen (Kolstad, Juel, Olsen & Lynge, 1995). Human health is not the only consideration, studies have also revealed numerous counts of marine life interactions with discarded polystyrene. If ingested, polystyrene beads often result in marine mortality (Moore, 2008).

Opportunities exist to remove EPS from the garbage stream. Spent EPS can be broken down and compressed into blocks which can be melted for the production of plastic. Removing EPS from the garbage stream enables the reuse of a product comprised of non-renewable petroleum and prevents the environmental burdens associated with its degradation.

6.3.2 EPS Recycling Opportunity in Dalhousie Labs

EPS contributes a vast amount of volume to the Dalhousie garbage stream. Although the majority of garbage disposal charges result from the weight of the waste, a lifting fee is also imposed each time a dumpster is emptied (R. Owen, personal communication, June 5th,

2014). During a meeting to discuss EPS disposal, one participant pointed out that although EPS does not contribute a great deal to the weight of the garbage stream, the additional volume fills dumpsters quickly and Dalhousie incurs extra lifting fees.

Truefoam Ltd. is a Dartmouth business specializing in EPS recycling. EPS can be transported to the facility where it is broken-down and compressed into blocks that can be melted to create plastic products (D. Ball, personal communication, July 14th, 2014). Dalhousie can partner with this local company to recycle EPS generated on Halifax campuses.

6.3.2.1 Dalhousie 'Styrofoam™' Recycling Pilot

Dalhousie plans to partner with Truefoam Ltd. in an EPS recycling pilot. The pilot has been titled the 'Styrofoam™ Recycling Pilot' due to familiarity of the Styrofoam™ brand. The pilot will be conducted in the Sir Charles Tupper Medical building as research identified this building to contribute large volumes of EPS to the garbage stream. Unused waste bins will be repurposed as EPS collection bins. Stickers will be adhered to the front of the bins and signage will be displayed above to identify the stream (Appendix F – G). The EPS bins will be placed next to the central bin sets located in the main hallway of each floor. Large pieces of EPS will be stacked on the floor next to the bin and small pieces will be placed inside the bin. Once full, custodial staff will transport the bins to a collection room located on the building dock. Truefoam Ltd. has provided canvas bags to collect and transport the EPS. The EPS will be placed in the canvas bags awaiting transport to Truefoam Ltd. via Dalhousie Grounds staff using a vehicle from the University's fleet. Procedural documents will be distributed to all lab users and building staff affiliated with the pilot (Appendix H – I) and mailroom staff will place educational stickers on all packages delivered to labs (Appendix J). The pilot is scheduled to last four months in which time volumes can be estimated for both base and peak EPS disposal periods; 'peaks' have been identified as the end and beginning of the school year. The volume of EPS transported to Truefoam Ltd. will be monitored to estimate requirements in other buildings and to determine transport and storage needs.

6.4 Paper Towel Composting

6.4.1 Paper Towel in the Waste Stream

The market demand for paper towel and tissue paper has steadily increased by four percent each year (Harrison, 1999). Theoretically, paper towel is compostable; however, Gregory, Montalbo and Kirchain (2013) indicate that it is commonly landfilled. With a growing demand for the product, it is important for paper towel to be composted when possible. Although composting will reduce the presence of paper towel in the landfill, Gregory, Montalbo and Kirchain (2013) determined that the disposal of paper towel (assuming it is landfilled) degrades the environment significantly less than its other life cycle stages including resource/material use, manufacturing, and transportation (as measured by contributions to global warming); therefore, alternatives to paper towel should be considered.

6.4.2 Composting Opportunity in Dalhousie Labs

Organics bins should be provided in labs that require heavy use of paper towel; however, it is crucial that only clean paper towel (i.e. paper towel used to wipe up water or dry clean hands) is discarded in the bins. Lab-specific bin signage and the Dalhousie Waste Guide will communicate that only clean paper towel may be added to the organics stream.

7.0 Waste Management Educational Material

Public participation is essential for the success of a recycling program; however, ensuring accurate disposal is also imperative (Thomas, 2001). Lab user participation is necessary to increase laboratory solid waste diversion from landfills; however, benefits are only experienced if participants sort waste accurately. Lab interviews and focus groups cited lab user and custodial staff lack of disposal knowledge as one of the main barriers to recycling in the lab; as such, the Dalhousie Waste Guide was designed to educate users on how to appropriately sort their waste and will assure custodial staff that the lab waste they handle is innocuous.

Floz (1991) stated that public involvement can encourage citizens to participate in waste programs with an intrinsic obligation to help the program succeed; therefore, lab users and custodial representatives were involved in the development of the guide. Perrin and Barton (2001) explain that recycling must be convenient and that participants require adequate knowledge for the success of the program; thus, it was extremely important for the Dalhousie Waste Guide to provide relevant information in a concise format.

7.1 Dalhousie Waste Guide

The Dalhousie Waste Guide was prepared using information from an existing campus-wide waste management guide and incorporating aspects of waste management specific to a laboratory setting. The guide is to be accompanied by the Empty Hazardous Material Container Recycling Procedures which provides details pertaining to the disposal of plastic and glass containers that held hazardous waste. Interviews and focus groups with lab stakeholders contributed to the development of the Dalhousie Waste Guide. Drafts of the guide were shared with stakeholders on several occasions requesting feedback then incorporating suggestions into future editions (e.g. suggestions provided in interviews and focus groups inspired the inclusion of the 'Excess Goods' section). Given the complex disposal procedures for hazardous waste, rather than providing comprehensive information for these streams, the guide provides contact information for the Dalhousie Environmental Health and Safety Office. The Dalhousie Waste Guide has been finalized and will be constantly updated to reflect future solid waste diversion initiatives in labs (Appendix K).

8.0 Laboratory Bin Standards

8.1 Dalhousie Laboratory Bin Standards

The "Indoor Waste Bin Standards for Dalhousie University" indicates specific bin and signage requirements for waste bins in all areas of the University aside from laboratories. Whereas many locations have standard needs (i.e. most auditoriums on campus have the same bin requirements), laboratory bin requirements are unique and dependent upon the waste generated within each lab. Lab stakeholders identified space constraints in many labs and emphasized the necessity for flexible bin standards. To accommodate the specific needs of each lab, laboratory

bin standards are less stringent than standards in other areas on campus. Bins should be determined by the lab P.I. and provided for the material stream(s) most prevalent in the lab; the P.I. can choose between paper, recyclables, and/or organics bins. The introduced bins will be used as 'transport bins' that collect recyclables within the lab. Once full, lab users will use the bins to transport the waste to the central hallway bin set where the contents can be emptied into the appropriate stream for regular collection by custodial staff. The "Indoor Waste Bin Standards for Dalhousie University" has been revised to include laboratories (Appendix L).

8.2 Dalhousie Laboratory-Specific Bin Signage

"Indoor Waste Bin Standards for Dalhousie University" outline specific signage requirements for bins located on campus. Signage has been designed to accommodate the four most common waste streams: paper, recyclables, organics, and garbage. Additional signage is available for 'refundables' bins and broken glass boxes. The signage depicts the most common type of materials placed in each stream (Appendix M).

Focus group participants encouraged the creation of lab-specific bin signage as streams within the lab are used to collect different types of materials from those identified on the signage used elsewhere on campus. Literature indicates that one of the biggest barriers to recycling is a lack of convenience and the degree to which participants must adapt their current behavior (Perrin & Barton, 2001). Currently there are limited opportunities to recycle in the lab; therefore, most waste is discarded in garbage stream. The introduction of recycling streams will require participants to adjust their sorting behavior. To reduce the uncertainty and resulting inconvenience, lab-specific bin signage will be displayed on the bin to outline the materials that are typically discarded in each stream. The signage incorporates the same colour-coding that is applied in other areas of campus (paper: gray, recyclables: blue, organics: green, and garbage: black) and provides pictorial and textual references for each stream. For ease of use, the signage is a self-adhesive so it can be easily placed on the front of the bin (Appendix N).

8.2.1 Repurposing Unused Bins

Interview and focus group participants have suggested that the financial burden of implementing new bin standards should be absorbed by the University and not the individual

lab users. To address this concern, unused waste bins can be repurposed to discourage the purchase of new bins. A waste bin audit is planned for the near future, the audit will result in the identification and removal of excess garbage bins from areas on campus. A large number of surplus garbage bins is anticipated, these bins will be set aside to be repurposed as needed. P.I.s will be able to request unused bins and can place the lab-specific bin signage on the front of the bin to identify the waste stream.

9.0 Recommendations

The Dalhousie Green Labs project has presented recycling and composting procedures for several waste materials (Table 2).

9.1 Styrofoam™ Recycling Pilot

The EPS recycling procedures and educational materials have been finalized and it is recommended that the Styrofoam™ Recycling Pilot commence immediately (it is tentatively scheduled for February, 2015). Upon successful implementation of the pilot, the EPS recycling program should be implemented across all Halifax campuses.

9.2 Additional Research

Lab visits, interviews, and focus groups identified barriers to solid waste diversion not thoroughly discussed in this report. Additional research should be conducted to identify opportunities to reduce the environmental burden associated with the following materials that are commonly discarded in the lab: disposable lab aprons, gloves, and sanitary cloths.

Table 2: Dalhousie Green Labs recommendations

Waste material	Recommendations	Goal timing
Lab plastic	Initiate lab plastic container and packaging recycling university-wide immediately.	Short-term
Lab glass	Initiate lab glass container and bottle recycling university-wide immediately.	Short-term
EPS	Initiate the Styrofoam™ Recycling Pilot in the Sir Charles Tupper Medical building to trial procedures.	Short-term
	Upon completing the pilot and amending the procedures as required, implement EPS recycling on all Halifax campuses.	Long-term
	As EPS recycling is not currently available in Bible Hill, continually monitor for EPS recycling opportunities for the Dalhousie Agricultural Campus.	Long-term
Lab paper towel	Organics bins should be provided in labs that generate a large amount of paper towel. Clean paper towel (used to wipe up water and dry clean hands) should be placed in the organics bin.	Short-term
	Research should be conducted to identify the most environmentally benign (yet economical) means to dry hands and this mechanism should be implemented in each lab as finances permit.	Long-term
Disposable lab aprons	Given restrictions in the Dalhousie Policy for Personal Protective Equipment, lab coats cannot leave the lab for home laundering; consequently, disposable aprons are worn and ultimately landfilled. The establishment of an in-house laundering service could permit cloth lab coats to be worn and safely cleaned for reuse.	Long-term
Disposable gloves	Disposable gloves were identified as a large contributor to the lab waste stream. Recycling opportunities should be researched for disposable gloves used in Dalhousie laboratories. The researcher must be considerate of the fact that the gloves are used for protection from a number of substances; therefore, gloves must be assessed for a variety of uses. Alternatively, research should be conducted to identify the most environmentally benign gloves that impose the least environmental impact if landfilled.	Long-term
Disposable sanitary cloths	Research should be conducted to identify the most environmentally benign means to wipe down lab surfaces and this mechanism should be used in all labs.	Long-term

10.0 Conclusion

Dalhousie University has established aggressive targets for diverting solid waste from the landfill. Research suggests that solid waste generated in Dalhousie labs contributes significantly to the garbage stream; however, in theory, the materials identified as key contributors to solid waste could be diverted through recycling or composting. Although specific weights and

volumes are unknown, it can be assumed that the introduction of recycling/composting procedures for plastic containers and packaging, glass containers and bottles, EPS, and paper towel will significantly reduce contributions to the garbage stream. Not only were these materials described as substantial contributors to the waste stream, they also inflict various environmental burdens if landfilled. The introduction of lab recycling procedures and the distribution of supporting documents including the Dalhousie Waste Guide, laboratory bin standards, and lab-specific bin signage will assist Dalhousie University in achieving its goal of 70% solid waste diversion from the landfill by 2020. The province of Nova Scotia is recognized internationally as a leader in solid waste management, the University's commitment to diversion will help Dalhousie attain similar recognition. Through the implementation of diversion programs, Dalhousie University can lead by example and inspire other universities to embrace laboratory solid waste diversion procedures.

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12.0 Appendices

Appendix A: Green Labs Focus Group Script #1

Good afternoon, my name is Sarah Miller and I am completing a Master of Resource and Environmental Management at Dalhousie University. This is Rochelle Owen, the Director of the Office of Sustainability. With funding from the Resource Recovery Fund Board and support from the Office of Sustainability, I am completing a study titled *Dalhousie Green Labs.* Rochelle and I will be co-facilitating the focus group today.

Dalhousie University has committed to a solid waste diversion target of 70%; currently, the University is achieving approximately 60% diversion. Although Dalhousie has made progress toward this goal, Dalhousie laboratories continue to encounter solid waste diversion challenges.

The objective of the focus group today is to identify concerns regarding solid waste sorting and collection, to gather feedback for the preparation of a laboratory solid waste sorting guide, and to develop laboratory bin standard recommendations. Notes and recordings from this session will be stored in a secure location at Dalhousie until December 2014, at which point all documents will be destroyed. Please keep all information from this discussion and the identity of your fellow participants confidential.

To begin the focus group, let's take a moment to introduce ourselves.

Focus Group Questions

1.) During lab visits and interviews, it has been suggested that the materials that most contribute to the garbage stream include: disposable gloves, paper towels, Kimwipes, plastic, and glass. Is there anything you would add to or remove from this list?

2.) Some Biology labs at UBC Okanagan use reusable dish gloves in undergrad classes for animal dissections. Students wash their gloves at the end of each class, then hang them on a clothes line to dry. Is this something that could be considered in some labs at Dal?

3.) We would like to include a section in the guide titled 'Tips for Reducing and Reusing', can you think of any opportunities for lab users to reduce or reuse in the lab setting?

4.) If there was an opportunity to triple-rinse, deface, and recycle plastic or glass containers that held benign chemicals, do you think lab users would know which containers were safe to recycle?

5.) What resources are currently available to laboratory users to identify the most appropriate disposal method for waste?

6.) What are some of the main barriers to recycling/reusing material in the laboratory setting?

7.) What kinds of bins (ex. organic, paper, etc.) do you think would most encourage recycling and reduce contamination?

8.) Do you see any safety concerns associated with the removal of some of the garbage bins and the addition of recycling/organics bins instead?

9.) Please think from a lab user's perspective, what do you think are some of the main concerns surrounding waste sorting in Dalhousie laboratories?
    a. Do you have any ideas for how these concerns can be overcome?

10.) Please think from the perspective of custodial staff, what do you think are some of the main concerns surrounding waste collection in Dalhousie laboratories?
    a. Do you have any ideas for how these concerns can be overcome?

11.) There may be an opportunity to collect and recycle Styrofoam. Is this something that would be helpful for labs in the Tupper?
    a. The recycling company provides large bags to collect the Styrofoam in, do you think this collection bag could be stored in the waste collection area downstairs?
    b. If so, could Styrofoam from other buildings be brought here?

Closing

That brings us to the end of today's focus group. Thank you so much for your time and contributions to the study. The recording from this meeting will be analyzed and will contribute to the preparation of a final report and presentation.

I would just like to reiterate that all information shared today is confidential, so please do not share the identity of the other focus group participants or any of the information shared in today's discussion. If a direct quote is to be included in any report or presentation, you will first be contacted for consent and will have between September 15th, 2014 and October 15th, 2014 to review the inclusion. If you wish to remain anonymous, or do not provide written consent, the information will be paraphrased and not directly cited, or a pseudonym will be used in place of your name. If you have any questions, please do not hesitate to contact me directly; my contact details are included at the top of the consent form. Alternatively, please feel free to reach out to the Dalhousie Research Ethics Office.

Appendix B: Green Labs Focus Group Script #2

Good afternoon, my name is Sarah Miller and I am a Resource and Environmental Management Master student at Dalhousie University. This is Rochelle Owen, the Director of the Office of Sustainability. With funding from the Resource Recovery Fund Board and support from the Office of Sustainability, I am completing a study titled *Dalhousie Green Labs.* Rochelle and I will be co-facilitating the focus group today.

Dalhousie University has committed to a solid waste diversion target of 70%, currently, the University is achieving approximately 60% diversion. Although Dalhousie has made progress toward this goal, Dalhousie laboratories continue to encounter solid waste diversion challenges. This research has been designed to assess the waste streams generated in labs across all four Dalhousie campuses; develop an understanding of the challenges associated with solid waste diversion and collection in labs, identify lab bin standards that will most encourage appropriate sorting, prepare a laboratory solid waste sorting guide for lab users, and standardize solid waste collection protocol.

The objective of the focus group today is to gather feedback to contribute to the finalization of the laboratory solid waste sorting guide and the laboratory bin standard recommendations. The focus group should last approximately 1.5 hours during which time I will ask a series of questions. If any question or discussion topic becomes uncomfortable, we will move on to the next question. I will record the session and the recording will be accessible only to Rochelle and me. Notes and recordings from this session will be stored in a secure location at Dalhousie until December 2014, at which point all documents will be destroyed. Please keep all information from this discussion and the identity of participants confidential.

To begin the focus group, let's take a moment to introduce ourselves.

Bin Standards

We will start off this meeting by discussing bin standards. We will discuss three potential recycling streams, the recycling procedures chosen to manage these streams will determine the specific bins to recommend within the Bin Standards document.

Part 1: Lab Plastic Recycling

A meeting was held with an HRM representative to discuss lab plastic recycling opportunities. He indicated that all **clean** lab plastic is recyclable aside from disposable gloves, aprons, and lab bench covers. A subsequent meeting was held internally and it was suggested that all lab plastic should be safe to recycle if cleaned using appropriate cleaning procedures and the label defaced. An exception to this rule is plastic that was used with hydrofluoric acid.

Clean lab plastic can be collected within the lab, and then placed in the 'recyclables' bin in the hallway PROG set.

a.) What do you think would be the best way for lab users to collect plastic within the lab? Is a central recyclables bin in the lab feasible?

b.) Do you have any additional feedback on this recycling procedure?

Part 2: Lab Glass Recycling

There are two potential alternatives for glass recycling that I would like to gather your feedback on. I will explain the two alternatives verbally, but for simplicity, I will represent the alternatives pictorially as well.

Scenario 1: A 32 gallon, 2 wheeled glass collection bin would be located in the hallway near the lab. Glass **containers** would be deposited by hand directly into the hallway bin (only glass containers would be placed in this bin as it has been assumed that dumping broken glass into the hallway bin could pose risk to lab users). Once full, the hallway bin would be collected and brought to the MRF for recycling. The MRF will only accept glass containers and will not accept lab glassware like beakers and test-tubes. The MRF does not charge a tipping fee for glass.

Scenario 2: The second scenario is modelled after the University of Victoria. In this scenario, glass would be collected in a small bin in the lab, once full, the bin is brought to the loading dock and emptied into a large tote. Once full, the tote is emptied into a rented compactor. The compactor is then collected by a waste hauler (U. Vic. uses Waste Management). In this scenario, bins are only required in the lab and a large tote in the loading dock or waste room, there would not be a hallway glass bin. As all glass (including lab glassware) would be collected in this scenario, we cannot bring the glass to the MRF; however, Halifax C & D would accept all glass at a cost of $75/ton.

a.) It is yet to be determined who collects the glass and who will transport the glass to the recycling facility. Having said that, can you please share your feedback on each scenario?

Part 2: Styrofoam Recycling

Background: Currently Styrofoam is discarded in the garbage stream; however, this material can be recycled through a company in Dartmouth called Truefoam. There is no charge to drop-off the Styrofoam with Truefoam. I would like to share a potential Styrofoam recycling scenario with you, this scenario has two options for storing the Styrofoam prior to transport to Truefoam.

A two wheeled hallway Styrofoam bin would be introduced. Lab users will bring individual pieces of Styrofoam to this bin. Once full, the bin will be transported to a storage location where it can be emptied into large canvas bags provided by Truefoam. I have two suggestions for storing the Styrofoam:

Scenario 1: Currently, Styrofoam is included in the garbage stream, theoretically, if we remove the Styrofoam from the garbage stream, the location where garbage is currently stored should have additional space, so the Styrofoam could be stored in the garbage room. Given the lightweight nature of Styrofoam, the canvas bags could be placed on a hook that mechanically suspends the Styrofoam above the garbage until being transported to Truefoam.

Scenario 2: A storage shed is built next to the building generating the Styrofoam – the Styrofoam bins would be wheeled to the shed and emptied into canvas bags where the bags would be picked up at a later time for transport to Truefoam.

a. Can you please provide feedback on the two storage scenarios?
b. Is it feasible for lab users to deposit Styrofoam directly into the hallway bins?

Part 3: Bin Requirements

Background: Whereas other areas of campus have specific bin requirements, lab bin standards will be flexible. Depending on the activity in the lab, lab managers can select the most appropriate bins. In most situations, lab recycling bins are considered ‘transport bins’, these bins are filled within the lab and once full, are used to transport waste materials into the larger hallway bins. Lab managers can select from the following transport bins: paper, recyclables (which would primarily be used for plastics), and organics (which would be primarily used for clean paper towel).

If a lab manager chooses to have bins for these materials in their lab, they may repurpose an old bin. We are designing lab-specific stickers that can placed on the front of bins. The sticker will identify the waste stream and will indicate the appropriate materials to be placed within this stream (it will be specific to waste materials generated in a lab setting). I’d like to share a draft of the lab stickers with you to gather your feedback. Just a note, we would work with Design Services to add appropriate graphics to each sign, we would just like to gather your feedback on the materials listed on each sticker:

a. Do you have any feedback for the paper/recyclables/organics/garbage sticker?
b. Is there anything else that should be added/removed to the materials list?

Laboratory Solid Waste Sorting Guide

The solid waste sorting guide is not quite complete. We are still working out potential recycling procedures for glass and Styrofoam; once finalized, the guide will be updated accordingly. Once we have all information we will meet with Design Services to finalize the layout *(show a draft of the guide)*.

1. Do you think that the waste streams and information boxes included in the guide are appropriate? Should anything be added or removed?

2. Do you think that the plastic disposal procedures are suitable? Or should there be more/less information provided?

3. You'll notice that the 'what belongs' section for lab glass is incomplete (represented by XXX), this is because if Dal chooses to move forward with glass recycling, we don't yet know if all glass will be recycled or if just containers will be recycled; having said that, do you feel that the glass disposal procedures are suitable? Or should there be more/less information provided?
4. Are there any simple opportunities to reduce or reuse within the lab setting not listed here?

Closing

That brings us to the end of today's focus group. Thank you so much for your time and contributions to the study. The recording from this meeting will be analyzed and will contribute to the preparation of a final report and presentation.

I would just like to reiterate that all information shared today is confidential, so please do not share the identity of the other focus group participants or any of the information shared in today's discussion. If a direct quote is to be included in any report or presentation, you will first be contacted for consent and will have between October 1st, 2014 and October 15th, 2014 to review the inclusion. If you wish to remain anonymous, or do not provide written consent, the information will be paraphrased and not directly cited, or a pseudonym will be used in place of your name. If you have any questions, please do not hesitate to contact me directly; my contact details are included at the top of the consent form. Alternatively, please feel free to reach out to the Dalhousie Research Ethics Office.

Thank you again, and it has been nice speaking with all of you today.

Appendix C: Lab Interview Questions

Good (morning/afternoon/evening), my name is Sarah Miller and I am a Resource and Environmental Management Masters student at Dalhousie University.

I would like to begin by offering some background information regarding this project. Dalhousie University has committed to a solid waste diversion target of 70%; currently, the University is achieving approximately 60% diversion. Although Dalhousie has made progress towards this goal, Dalhousie laboratories continue to encounter solid waste diversion challenges. This research has been designed to assess the waste streams generated in labs across all four Dalhousie campuses, develop an understanding of the challenges associated with solid waste diversion and collection in labs, identify lab bin standards that will most encourage appropriate sorting, prepare a laboratory solid waste sorting guide.

The objective of all interviews conducted is to provide insight into the types of waste created in Dalhousie laboratories and to identify some of the current waste collection challenges and barriers to diverting waste from landfills. The information gathered will be essential for the creation of the solid waste sorting guide, the identification of appropriate protocol for solid waste collection, and the development of bin standards to enhance diversion in Dalhousie labs across all four campuses.

I will record the session and the recording will only be accessible to me and my research supervisor. Notes and recordings from this session will be stored in a secure location at Dalhousie until December 2014, at which point all documents will be destroyed. If any question makes you feel uncomfortable, please let me know and we can move on to the next topic.

Interview Questions

1.) What do you think is the most common material(s) found in the lab waste stream?

2.) What kinds of lab waste do you think cause the most confusion in terms of sorting for disposal?

3.) What resources are currently available to laboratory users to identify the most appropriate disposal method for waste?

4.) What are some of the main barriers to recycling/reusing material in the laboratory setting?

5.) What combination of waste stream bins do you think would most encourage recycling (and reduce contamination), for example, organics, garbage, etc.?

6.) Are laboratory bins often full when collected?

7.) Do you think the collection schedule is appropriate? Or is it too often/too infrequent?

8.) Do you see any safety concerns associated with removal of some of the waste bins?

9.) What are some of the main concerns surrounding waste sorting and collection in Dalhousie laboratories?
    a. Do you have any ideas for how these concerns can be overcome?

10.) Of the lab waste that is added to the garbage stream, if one or two types of waste (for example, paper) could be recycled, which do you think would most increase diversion from the landfill?

11.) We will be holding a focus group to gather additional information to prepare the lab waste sorting guide and to develop laboratory bin standards. We would like to invite laboratory managers and technicians. Can you recommend any managers or technicians whom we should invite to participate?

Closing

That brings us to the end of our interview. Thank you so much for your time and contributions to this study. The recording from this meeting will be analyzed and will contribute to the preparation of a final report and presentation.

I would just like to reiterate that all information shared today is confidential.

If a direct quote is to be included in any report or presentation, you will first be contacted for consent and will have between September 1st, 2014 and October 1st, 2014 to review the inclusion. If you wish to remain anonymous, or do not provide written consent, the information will be paraphrased and not directly cited, or a pseudonym will be used in place of your name. If you have any questions please do not hesitate to contact me directly; my contact details are included at the top of the consent form. Alternatively, please feel free to reach out to the Dalhousie Research Ethics Office.

Appendix D: Focus Group/Lab Interview Informed Consent Form

Dalhousie Green Labs Informed Consent Form – Focus Group/Interview
Research Study: Dalhousie Green Labs
Conducted by: Sarah Miller, the Office of Sustainability, and Dalhousie University
Student Researcher: Sarah Miller; sarah.miller@dal.ca
Research Supervisor: Rochelle Owen, the Office of Sustainability, Dalhousie University
Contact: rjowen@dal.ca or 902-494-7448

Research Questions: What are the solid waste streams in laboratories across the four Dalhousie campuses? Of this waste, what can be diverted from landfills through reduction, reuse, recycling, and composting efforts? What bin standards will most encourage safe and effective recycling participation from laboratory users?

Purpose of Research: To increase solid waste diversion in Dalhousie laboratories, educate laboratory users on appropriate solid waste sorting practices, and ensure safe and consistent collection of laboratory waste.

Risks and Benefits: There are no foreseeable risks associated with this study; however, if any part of this discussion makes you uncomfortable, please inform the researcher, and we will move on to the next question.

Participation and Withdrawal: Participation in this study is voluntary. If you feel uncomfortable at any time throughout the focus group/lab visit/lab meeting, you may withdraw from participation. There is no penalty to withdraw from participation.

Confidentiality and Anonymity: This meeting will be strictly confidential and the audio recordings from this meeting will be accessible only to the student researcher and research supervisor. Recordings will be stored in a secure location in the Office of Sustainability and the transcriptions of the recordings will be stored on a secure computer. If a direct quote is to be included in any report or presentation, you will first be contacted for consent and will have between *date* and *date* to review the inclusion. If you wish to remain anonymous, or do not provide written consent, the information will be paraphrased and not directly cited, or a pseudonym will be used in place of your name.

Results: Once all research has been completed, a report and presentation will be prepared. As a research participant, you may request a copy of this report from the Office of Sustainability once it is complete. Research findings will be presented in December 2014 in the School for Resource and Environmental Studies. The presentation is open to the public and you are welcome to attend.

Rights of Research Participants: Participation in this study is voluntary and you may withdraw from participation at any time. If you have any questions or would like additional information regarding this project, please feel free to contact the student researcher or research supervisor (contact details listed above). The Dalhousie University Faculty of Management Ethics Board has reviewed this study and is available to address any questions regarding your rights as a participant. If you require additional information, please contact the student researcher's academic advisor, Peter Duinker, at peter.duinker@dal.ca.

Consent (only check statements that you agree with)

☐ I agree to participate in this study
☐ I give permission to tape record the focus group/lab interview

Participant Signature: _____ Date: _____

Appendix E: Glass recycling procedures at other schools

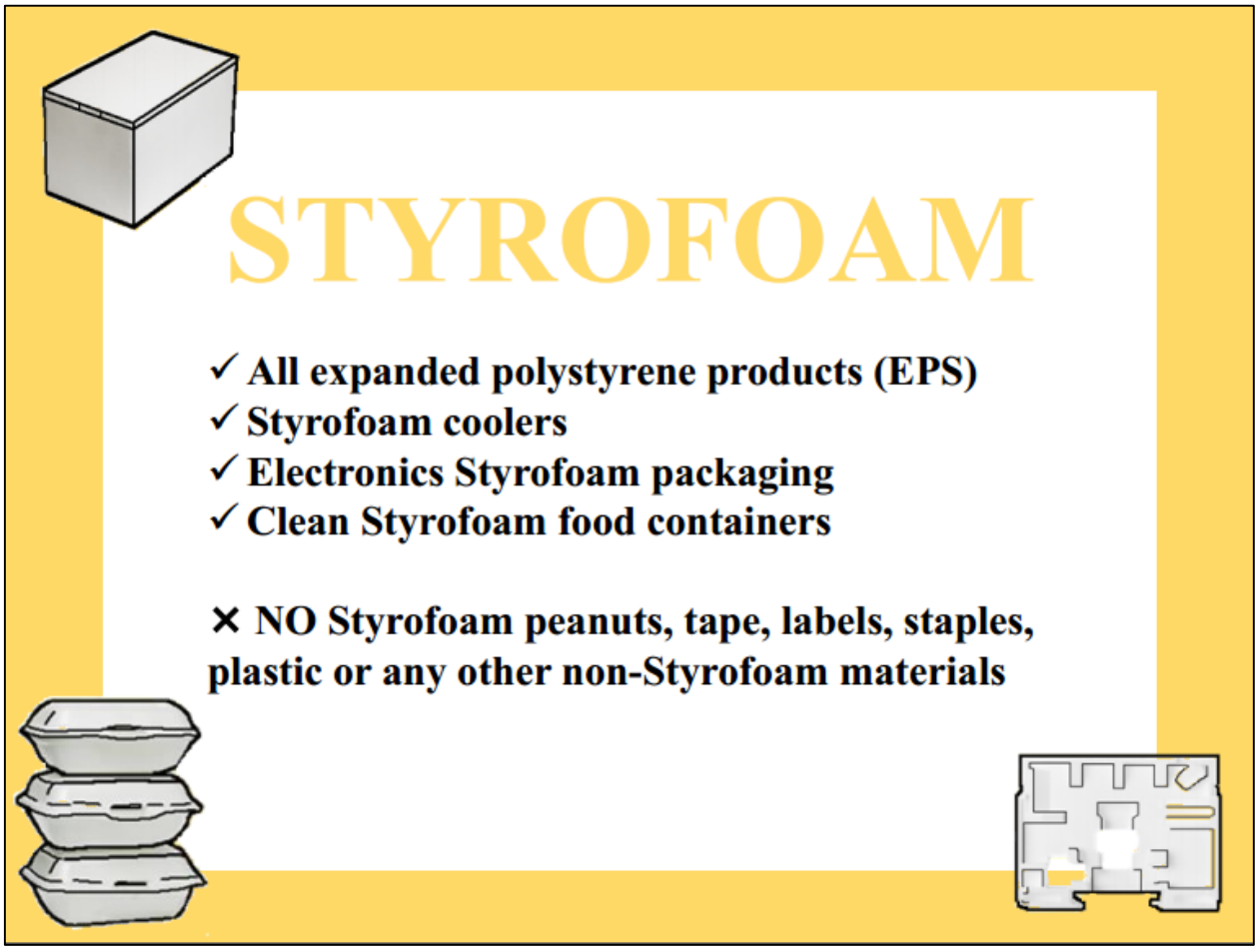
	Glass collection bins	Collection and transport to storage location	Storage mechanism	Transport to recycling facility
University of Alberta*	Glass is collected in 5 gallon pales in the labs. Once full, the bins are placed in the hallway outside of the lab below a sign specifically designating an area for glass collection.	Custodial staff picks up the bucket and tips it into a toter. The **toter is wheeled down to the loading dock.	Glass is stored in the toter and is eventually lifted (using a tipper) and tipped into a Waste Management compactor where it is stored for pick-up.	Waste Management collects the contents stored in the compactor and transports it to the Municipality for processing.
University of Victoria*	Glass is collected in small bins within the lab.	Once full, Facilities collects all bins and brings them to the loading dock.	Glass is tipped into a toter. Once full, the toter is tipped into a compacter using a tipper.	Waste Management collects the contents of the compactor.
University of Toronto*	Glass is collected in toters. The toters are located in the lab (if space permits); alternatively, the toters are kept in a central location (e.g. the hallway) if the lab is too small. If the lab is too small to store a toter, a small pale is used to collect glass, once full it is tipped into the central toter.	Once full, custodial staff exchanges the full toters with empty ones. The full toters are taken to the loading dock.	Glass is stored in the toter in which it was collected.	A contractor visits the loading dock and wheels the full toters into a truck. The contractor returns the toters once emptied.
Laval University*	Glass bottles are collected in bins in the hallway. The bins are lined with bags. Glass is mixed with plastics in this bin.	Once full, custodial staff place the bags in a cart that is used to transport the glass/plastic to the loading dock.	The bags of glass/plastic are transferred manually from the cart into a toter in the loading dock.	The toters are collected by the Municipality. Municipal trucks with automatic tippers pick-up the toter and tip the contents into the back of the truck.
University of Ottawa (Medical Faculty)*	Glass bottles are collected within the lab. Bottles are triple-rinsed and placed in the fume hood to air-out.	There are 100 labs, a Technical Support Group collects glass bottles from 80 labs and 20 labs transport their own waste. When the fume hood needs to have its contents (bottles) emptied, the bottles are taken to the waste room. For the 80 labs that are serviced by the Technical Support Group, the bottles are collected in a cart and wheeled to the waste room.	Bottles are aired-out for additional time on shelves in the waste room. Eventually the bottles are placed in toters for collection by the waste service provider.	The waste service provider wheels the full toters into their truck. The full toters are replaced with empty toters for future collection.

* Data provided by university staff associated with laboratory solid waste recycling procedures.

** A toter is a large wheeled waste bin with a hinged lid.

Appendix F: Styrofoam™ Recycling Pilot Bin Signage

Appendix G: Styrofoam™ Recycling Pilot Bin Sticker



Appendix H: Styrofoam™ Recycling Pilot Details (Lab Users)

Background

Expanded polystyrene (EPS) is often referred to as Styrofoam; however, in reality, Styrofoam is a brand name for EPS manufactured by the Dow Chemical Company. EPS is a petroleum-based product that is typically manufactured for one-time use (Suwanmanee et al., 2012). The generation, use, and subsequent disposal of EPS products inevitably contributes to greenhouse gas, acidification, and the creation of smog (Zabaniotou & Kassidi, 2003). Additionally, health concerns are associated with the degradation of EPS. Styrene is manufactured using benzene and ethylene monomers, then polymerized to create polystyrene (Uihlein, Ehrenberger & Schebek, 2008). The degradation of polystyrene into styrene and benzene is concerning; benzene has been identified as a carcinogen (Duarte-Davidson, Courage, Rushton & Levy, 2001) and styrene is considered a neurotoxin and carcinogen (Kolstad, Juel, Olsen & Lynge, 1995). Human health is not the only consideration, studies have also revealed numerous counts of marine life interactions with discarded polystyrene. If ingested, polystyrene beads often result in marine mortality (Moore, 2008).

Truefoam

Truefoam Limited is a Dartmouth-based business specializing in EPS recycling. EPS can be transported to this facility where it is broken down and compressed into blocks that can be melted to create plastic products. Dalhousie plans to partner with Truefoam Ltd. in an EPS recycling pilot running between February 2015 and May 2015. The pilot will be conducted in the Sir Charles Tupper building as research identified this building to contribute large volumes of EPS to the waste stream. Unused bins will be repurposed as 'Styrofoam' bins which will be located near central waste systems currently located in the main hallway on each floor.

Styrofoam Recycling Procedures (Lab Users)

1.) Clean Styrofoam generated in the lab must be recycled. Recycling bins are located in the hallway. It will be picked up by custodial staff during regular collection.
2.) Styrofoam must be **free from labels, tape, and any other material**.
3.) Small or broken pieces of Styrofoam can be placed in the Styrofoam bin and large pieces of Styrofoam can be placed on the floor beside the bin.

Please contact Building Services (902-494-2222) if you have any questions regarding this program

Appendix I: Styrofoam™ Recycling Pilot Details (Facilities Management)

Background

Expanded polystyrene (EPS) is often referred to as Styrofoam; however, in reality, Styrofoam is a brand name for EPS manufactured by the Dow Chemical Company. EPS is a petroleum-based product that is typically manufactured for one-time use (Suwanmanee et al., 2012). The generation, use, and subsequent disposal of EPS products inevitably contributes to greenhouse gas, acidification, and the creation of smog (Zabaniotou & Kassidi, 2003). Additionally, health concerns are associated with the degradation of EPS. Styrene is manufactured using benzene and ethylene monomers, then polymerized to create polystyrene (Uihlein, Ehrenberger & Schebek, 2008). The degradation of polystyrene into styrene and benzene is concerning; benzene has been identified as a carcinogen (Duarte-Davidson, Courage, Rushton & Levy, 2001) and styrene is considered a neurotoxin and carcinogen (Kolstad, Juel, Olsen & Lynge, 1995). Human health is not the only consideration, studies have also revealed numerous counts of marine life interactions with discarded polystyrene. If ingested, polystyrene beads often result in marine mortality (Moore, 2008).

Truefoam

Truefoam Limited is a Dartmouth-based business specializing in EPS recycling. EPS can be transported to this facility where it is broken down and compressed into blocks that can be melted to create plastic products. Dalhousie plans to partner with Truefoam Ltd. in an EPS recycling pilot running between February 2015 and May 2015. The pilot will be conducted in the Sir Charles Tupper building as research identified this building to contribute large volumes of EPS to the waste stream. Unused bins will be repurposed as ‘Styrofoam’ bins which will be located near central waste systems currently located in the main hallway on each floor.

Styrofoam Recycling Procedures (Facilities Management)

1.) **Mailroom staff:** before distributing packages to laboratory recipients, please apply the *Styrofoam Recycling Pilot* sticker to the outside of the box.

2.) Lab users will place all small/broken pieces of Styrofoam into the Styrofoam recycling bin located next to the hallway PROG set. Large pieces of Styrofoam will be placed on the floor beside the Styrofoam bin.

3.) **Custodial staff:**
   a. During regular collection, custodial staff will collect the Styrofoam bin as well as the large pieces of Styrofoam placed beside the bins.
   NOTE: The Styrofoam bins will be in stacked in sets of two, once full, custodial staff will take the top bin (leaving the bottom bin in place).
   b. Custodial staff will bring the Styrofoam to the Styrofoam storage room (located in room LB92 on the Tupper dock) where they will transfer the Styrofoam into the canvas bags provided by Truefoam.

   c. During the next collection, custodial staff will return the empty Styrofoam bins (ensuring that each Styrofoam bin is again in a stack of two).

4.) Truefoam has provided 12 bags (that will have 'Dalhousie' spray-painted on the front) with the assumption that we will drop off the full bags six at a time.

5.) The bags are not emptied at Truefoam on the spot; therefore, with every drop-off, Truefoam will supply six empty bags to replace the full ones.

6.) **Grounds staff:**
   a. Once six canvas bags have been filled, grounds staff will transport the Styrofoam to Truefoam using one of the Dalhousie trucks.
   b. The full bags will be left at Truefoam and six empty bags will be provided to bring back to Dalhousie. The empty bags will be returned to room LB92 on the Tupper dock.

Please contact Building Services (902-494-2222) if you have any questions regarding this program

Appendix J: Styrofoam™ Recycling Pilot Mailroom Sticker

STYROFOAM RECYCLING PILOT

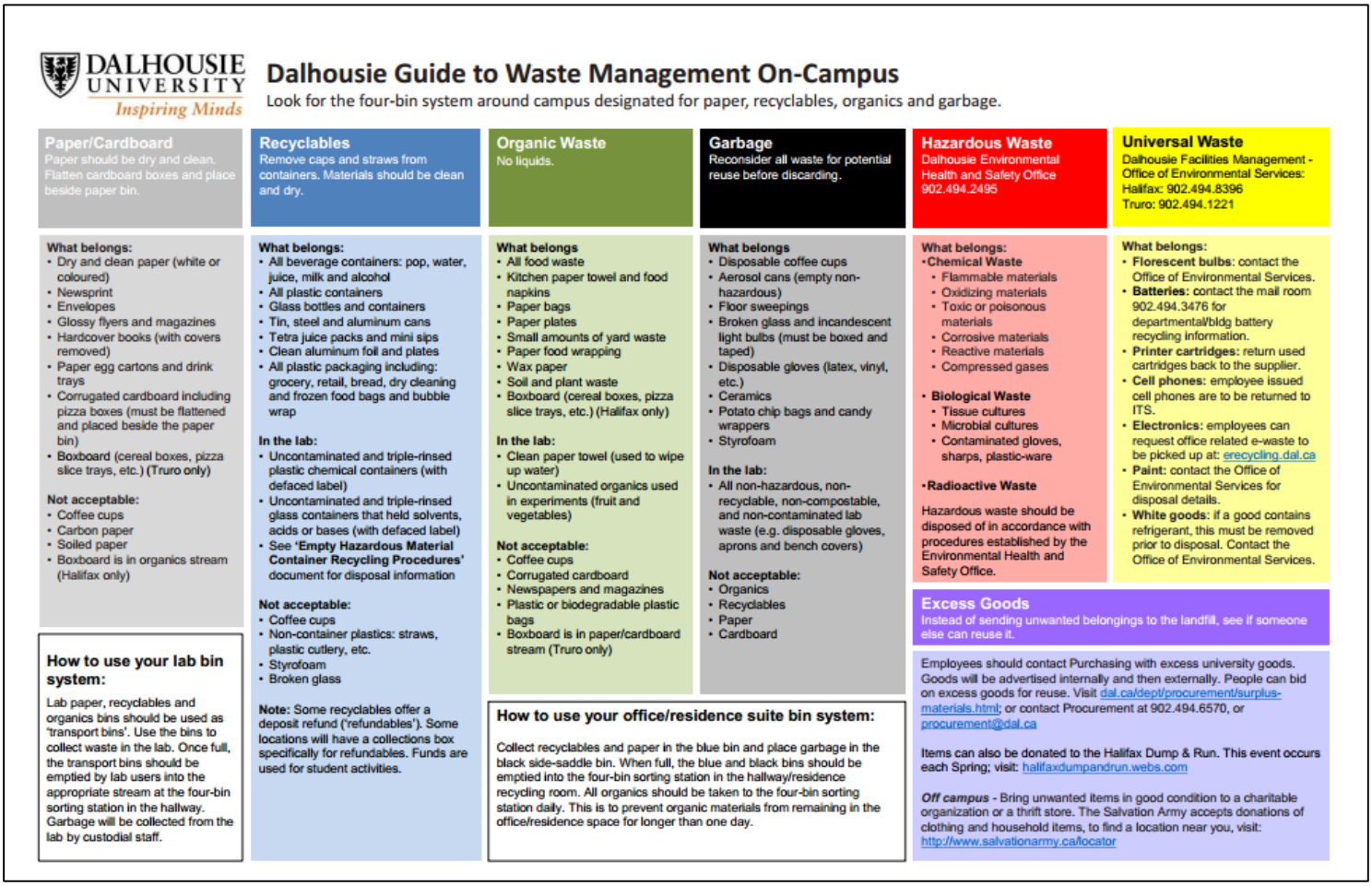
The Tupper Building has committed to a Styrofoam recycling pilot which will run from February 2015 until May 2015. We request the participation of all occupants to ensure a realistic representation of the volume of Styrofoam generated within this building. Thank you, we appreciate your participation.

Recycling Procedures:

1.) All clean Styrofoam generated in the lab must be recycled. Recycling bins are located in the hallway.
2.) Small or broken pieces of Styrofoam can be placed in the Styrofoam bin and large pieces of Styrofoam can be placed on the floor beside the bin.
3.) Styrofoam must be free from labels, tape, and any other material.

Please contact Building Services (902-494-2222) if you have any questions regarding this program.

Appendix K: Dalhousie Waste Guide (and Empty Hazardous Material Container Recycling Procedures Appendage)



DALHOUSIE UNIVERSITY
Inspiring Minds

Dalhousie Guide to Waste Management On-Campus

Look for the four-bin system around campus designated for paper, recyclables, organics and garbage.

Paper/Cardboard

Paper should be dry and clean. Flatten cardboard boxes and place beside paper bin.

What belongs:
- Dry and clean paper (white or coloured)
- Newsprint
- Envelopes
- Glossy flyers and magazines
- Hardcover books (with covers removed)
- Paper egg cartons and drink trays
- Corrugated cardboard including pizza boxes (must be flattened and placed beside the paper bin)
- Boxboard (cereal boxes, pizza slice trays, etc.) (Truro only)

Not acceptable:
- Coffee cups
- Carbon paper
- Soiled paper
- Boxboard is in organics stream (Halifax only)

Recyclables

Remove caps and straws from containers. Materials should be clean and dry.

What belongs:
- All beverage containers: pop, water, juice, milk and alcohol
- All plastic containers
- Glass bottles and containers
- Tin, steel and aluminum cans
- Tetra juice packs and mini sips
- Clean aluminum foil and plates
- All plastic packaging including: grocery, retail, bread, dry cleaning and frozen food bags and bubble wrap

In the lab:
- Uncontaminated and triple-rinsed plastic chemical containers (with defaced label)
- Uncontaminated and triple-rinsed glass containers that held solvents, acids or bases (with defaced label)
- See **'Empty Hazardous Material Container Recycling Procedures'** document for disposal information

Not acceptable:
- Coffee cups
- Non-container plastics: straws, plastic cutlery, etc.
- Styrofoam
- Broken glass

Note: Some recyclables offer a deposit refund ('refundables'). Some locations will have a collections box specifically for refundables. Funds are used for student activities.

Organic Waste

No liquids.

What belongs
- All food waste
- Kitchen paper towel and food napkins
- Paper bags
- Paper plates
- Small amounts of yard waste
- Paper food wrapping
- Wax paper
- Soil and plant waste
- Boxboard (cereal boxes, pizza slice trays, etc.) (Halifax only)

In the lab:
- Clean paper towel (used to wipe up water)
- Uncontaminated organics used in experiments (fruit and vegetables)

Not acceptable:
- Coffee cups
- Corrugated cardboard
- Newspapers and magazines
- Plastic or biodegradable plastic bags
- Boxboard is in paper/cardboard stream (Truro only)

Garbage

Reconsider all waste for potential reuse before discarding.

What belongs
- Disposable coffee cups
- Aerosol cans (empty non-hazardous)
- Floor sweepings
- Broken glass and incandescent light bulbs (must be boxed and taped)
- Disposable gloves (latex, vinyl, etc.)
- Ceramics
- Potato chip bags and candy wrappers
- Styrofoam

In the lab:
- All non-hazardous, non-recyclable, non-compostable, and non-contaminated lab waste (e.g. disposable gloves, aprons and bench covers)

Not acceptable:
- Organics
- Recyclables
- Paper
- Cardboard

Hazardous Waste

Dalhousie Environmental Health and Safety Office
902.494.2495

What belongs:
- **Chemical Waste**
  - Flammable materials
  - Oxidizing materials
  - Toxic or poisonous materials
  - Corrosive materials
  - Reactive materials
  - Compressed gases
- **Biological Waste**
  - Tissue cultures
  - Microbial cultures
  - Contaminated gloves, sharps, plastic-ware
- **Radioactive Waste**

Hazardous waste should be disposed of in accordance with procedures established by the Environmental Health and Safety Office.

Universal Waste

Dalhousie Facilities Management - Office of Environmental Services:
Halifax: 902.494.8396
Truro: 902.494.1221

What belongs:
- **Florescent bulbs:** contact the Office of Environmental Services.
- **Batteries:** contact the mail room 902.494.3476 for departmental/bldg battery recycling information.
- **Printer cartridges:** return used cartridges back to the supplier.
- **Cell phones:** employee issued cell phones are to be returned to ITS.
- **Electronics:** employees can request office related e-waste to be picked up at: erecycling.dal.ca
- **Paint:** contact the Office of Environmental Services for disposal details.
- **White goods:** if a good contains refrigerant, this must be removed prior to disposal. Contact the Office of Environmental Services.

How to use your lab bin system:

Lab paper, recyclables and organics bins should be used as 'transport bins'. Use the bins to collect waste in the lab. Once full, the transport bins should be emptied by lab users into the appropriate stream at the four-bin sorting station in the hallway. Garbage will be collected from the lab by custodial staff.

How to use your office/residence suite bin system:

Collect recyclables and paper in the blue bin and place garbage in the black side-saddle bin. When full, the blue and black bins should be emptied into the four-bin sorting station in the hallway/residence recycling room. All organics should be taken to the four-bin sorting station daily. This is to prevent organic materials from remaining in the office/residence space for longer than one day.

Excess Goods

Instead of sending unwanted belongings to the landfill, see if someone else can reuse it.

Employees should contact Purchasing with excess university goods. Goods will be advertised internally and then externally. People can bid on excess goods for reuse. Visit dal.ca/dept/procurement/surplus-materials.html; or contact Procurement at 902.494.6570, or procurement@dal.ca

Items can also be donated to the Halifax Dump & Run. This event occurs each Spring; visit: halifaxdumpandrun.webs.com

Off campus - Bring unwanted items in good condition to a charitable organization or a thrift store. The Salvation Army accepts donations of clothing and household items, to find a location near you, visit: http://www.salvationarmy.ca/locator

Empty Hazardous Material Container Recycling Procedures

Most plastic containers and glass containers (that held solvents, acids or bases) are recyclable. It is very important to appropriately dispose of empty hazardous material containers to avoid concerns as to whether there are still any hazards present. These containers must be empty and dry, with no chemical residue. If the rinse (water or other suitable solvent) used to clean a container is hazardous, it must be collected as hazardous waste and disposed of accordingly.

NOTE: If residue remains in the container after triple-rinsing (by means of rinsing with a suitable solvent, inverting, shaking and/or scraping) and the residue is hazardous, it must be disposed of as hazardous waste. It **cannot be recycled**. Bear in mind that these containers will ultimately be hand sorted by recycling employees.

Plastic Chemical Containers

Triple-rinse and recycle all uncontaminated plastic chemical containers (with defaced labels)

Procedures:

- Remove, clean and discard lid.
- Triple-rinse container with water, or suitable solvent.
- If rinse is hazardous, it must be collected as hazardous waste and discarded accordingly.
- Deface the label (use a pen to mark an 'X' through the original contents, or rip the label off) and write 'Rinsed Bottle' on it.
- Place clean and dry plastic in recyclables bin.

Not acceptable:

- Hard plastic (e.g. lids or trays)

Glass Chemical Containers

Triple-rinse and recycle uncontaminated glass chemical containers that held solvents, acids or bases (with defaced labels)

Procedures:

- Remove, clean and discard lid.
- Triple-rinse container with a suitable solvent.
- If rinse is hazardous, it must be collected as hazardous waste and discarded accordingly.
- Deface the label (use a pen to mark an 'X' through the original contents, or rip the label off) and write 'Rinsed Bottle' on it.
- Place clean and dry glass container in recyclables bin.

Not acceptable:

- Lab glassware (e.g. beakers, test tubes)
- Broken glass

Broken Glass:

Place all uncontaminated broken glass in a sturdy, puncture-resistant container (e.g. cardboard box). Once full, seal the container and label it 'Broken Glass' and place for disposal along with normal building garbage.

Contact the Dalhousie Environmental Services for Recycling and Disposal Options.
Contact the Dalhousie Environmental Health and Safety Office for information on hazardous waste disposal.

Appendix L: Laboratory Appendage to Indoor Waste Bin Standards for Dalhousie University

11. Laboratories

1. Dalhousie University has specific protocol for the collection of hazardous waste, biomedical waste and sharps. The appropriate bins must be provided within the lab as required by the Dalhousie Environmental Health and Safety Office.
2. P.I.s may select additional recycling bins for the lab based on the types of waste materials commonly generated. They may select from the following streams: Paper, Recyclables, Organics and Garbage.
3. Bin Description
    - The size and style of the bins used in the laboratory setting is flexible. To reduce the financial burden, P.I.s are encouraged to repurpose unused bins.
4. The bins chosen by the P.I. will be available to collect materials within the lab. The Paper, Recyclables and Organics bins are considered 'transport bins'; once full, each bin is used to transport the waste to a nearby four-bin hallway set where it should be emptied into the appropriate waste stream for collection by custodial staff. Garbage is collected by custodial staff from the lab.
5. Lab-specific bin signage should be adhered to the front of the bin to identify each stream. The signage provides details regarding the types of materials that can be placed in each stream and specifically addresses the types of waste generated in the lab setting.
6. The Dalhousie Waste Guide (Materials Sorting Poster and Empty Hazardous Material Container Recycling Procedures) should be displayed at eye-level in the lab to educate lab users on recycling processes for each stream.

Figure 16: Example of bins in the laboratory

Appendix M: Campus-Wide Waste Stream Signage

(Adapted from Ummat, 2013)

Appendix N: Lab Specific Waste Stream Signage