Promoting Waste Diversion through Site Specific Waste Bin Standards

Dalhousie University Case Study

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DALHOUSIE
UNIVERSITY
Inspiring Minds

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Figure 1: Bin System at Agricultural Campus, Dalhousie University, Truro, NS.

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1.0 Executive Summary

Research on waste source separation has shown that convenience plays a significant role in user waste sorting behaviour. Studies investigating the effect of different shape openings, eye-level signage and colour-coding have shown reduction in contamination in waste streams. Reduced contamination has also been reported when black bins are paired with recycling bins. Other studies show increased recycling where recycling facilities are easily accessible. The current study aims to design waste standards for Dalhousie University, which incorporate colour-coding different shape openings, signage, and reducing the number of single-use garbage bins on campus. The study has identified key space types for implementing these standards: hallways, classrooms, lunchrooms, and residences. Methods for this study included focus groups with custodial supervisors and their staff to gather feedback on the proposed changes for the implementation of the standards. Key locations for audits were suggested in focus groups and subsequent meetings with custodial staff over the course of the project. Interviews with the Kitchen staff at the Agricultural Campus and Sherriff Hall and tours of these kitchens and dining areas were also conducted to gather insights into waste management in these areas. Waste audits before (pre) and after (post) the changes were undertaken for some locations to demonstrate the impact of the new system on user behaviour for waste source-separation. These waste audits demonstrate the impact of the new system on waste diversion. For most locations, low volumes of waste were collected. The main reason for such low volumes is the short duration of the waste audit (3 days). Due to the low volumes of wastes, even single items of contaminations skewed the results. In the residences; however, high volumes of waste were audited. The implementation of the changes at the residence location showed reduction in contamination (58.1% to 43.3%) in the garbage stream. These short-term positive effects of the system should be studied over a long period for consistency of results. Given the low waste volumes and short duration of the waste audits in this study, it is difficult to assess if the changes were successful in promoting source-separation behaviour among the users. Long-term studies with higher volumes of waste will generate statistically significant trends. These results and trends will be useful to determine the success of the changes to promote increased waste sorting behaviour among users at Dalhousie. A document describing the waste bin design

guidelines for space types at campus was also prepared. This document will serve as a standards document for Facilities Management.

2.0 Background

The growth of the human population combined with economic progress has led to an increase in the volume of waste generated. Increased waste generation requires proper practices and procedures for its collection, processing and disposal. Waste management includes all activities that facilitate the collection, separation of wastes at the source, storage, transportation, transfer, processing, treatment, and disposal of waste (Nemerow et al., 2009). Waste may include solid waste (plastic, paper, food waste, etc); liquids; gases; and household hazardous, nuclear, and radioactive wastes. In many Canadian and US cities, source separation of the waste is required before its collection. Through source separation, waste is separated into different categories which identify items that are recyclable, compostable, and reusable. This system allows for diversion of waste materials from disposal sites. Diverted material can be used to manufacture new goods. Source separation or sorting of waste requires the users to separate their waste into relevant categories. Extensive research has been carried to understand waste sorting behaviour of users with hopes to encourage waste sorting and improve diversion rates.

2.1 Theory of Planned Behaviour and recycling

To increase the sorting/recycling behaviour of the users, the factors that influence their recycling behaviour must be understood. Ajzen's (1991) Theory of Planned Behaviour (TPB) postulates three independent factors to determine a behaviour: attitudes towards the behaviour (refers to the degree to which a person has favourable or unfavourable attitudes towards the behaviour); subjective norm (perceived social pressure to perform or not to perform the behaviour) and perceived behavioural control (the perceived ease or difficulty of performing the behaviour). Perceived behavioural control can also be understood as convenience. If people perceive recycling to be convenient and easy, they are more likely to engage in this behaviour. There have been studies that have used TPB to determine factors that influence recycling (Boldero 1995; Davies, Foxhall and Pallister, 2002; Tonglet, Phillips and Read, 2004). Within these studies, convenience of

recycling was shown to play a significant role in determining recycling behaviour. For example, Boldero (1995) showed that in addition to attitudes, factors related to inconvenience of recycling also played a role in determining the recycling behaviour of the household members. Tonglet et al. (2004) investigated perceived behavioural control with specific questions such as the opportunity to recycle, convenience of recycling, and ease of recycling among other questions. This study included additional variables of moral norm, past experiences, situational factors (too much space, too much money, too complicated, etc.), and consequences of recycling. The results of this study indicated that the appropriate skills, resources and opportunities can foster positive recycling attitudes. Attitudes towards recycling were also positive because of the perceived convenience of recycling in the region. The individuals felt that recycling is not too complicated and does not waste their time (Tonglet et al., 2004).

Convenience of recycling has also been researched outside the setting of TPB. Vining and Ebreo (1990) showed that inconvenience was cited as one of the major reasons for not participating in recycling. Similarly, Dahab, Gentry and Su (1995) identified that the perceived effort negatively affects the intention to participate in future recycling activities and outweighs the significance of attitudes towards recycling for predicting recycling behaviour. Convenience can be discussed in terms of the underlying factors that affect the perceived convenience of recycling behaviour. For example, the distance walked to the bins which in turn affect their accessibility. Accessibility can also decrease if the bins are not easily visible or difficult to locate. Gonzalez-Torre and Adenso-Diaz (2004) showed that as the distance to the bins from homes increased, the number of items that were separated decreased. Recycling effort (number of items separated at home) was encouraged by the proximity of the bins to homes. Distance minimization was used as a strategy to divert wastes from landfills by Gautam and Kumar (2005). Littering behaviour study conducted in Australia in 2001 showed that people at transport terminals and shops would put their waste in the bins within 3.5 metres while at the beach, people would walk up to 17 metres to put their waste in a bin (Community Change Pty Ltd, 2001). Based on results such as these, Stantec Consulting Limited (2009) suggests that the most effective placement of bins would be within 3 to 14 metres of each other. Also suggested as a best management practice, is the pairing of all black bins with recyclables to avoid

contamination and to place them side-by-side rather than back-to-back (Stantec Consulting Limited, 2009). During their evaluation of the recycling programs on rest stop areas along highways of California, Ohio and Wisconsin, Attardo, Chen and Napolean (2001) found that contamination rate was lower when recyclable containers were placed in a semi-circle behind the trash can over all containers in a straight line parallel to the sidewalk. When the city of Gosford, Australia placed new stations in several city parks, there was only one recycling bin next to the waste bin and in some instances, there were no recycling bins next to the waste bin. Standard New South Wales signage was used on these bins. The waste audits showed that the standalone garbage bins had 25% recyclables while the garbage bins paired with the recyclable bins had less than 10% recyclables. This example illustrates the importance of pairing waste and recyclable bins to recover more recyclables (Hyder Consulting, 2007 as cited by Stantec Consulting Limited, 2009).

Locating the recycling bins close to the user has shown positive influence on the recycling behaviour in various settings. Fewer contaminants were reported by Humphrey, Bord, Hammond and Mann (1977) in the recycling stream when containers were located in close proximity to office workers. Despite the use of reinforcements to increase the recycling behaviour among dormitory students by Witmer and Geller (1976), the greatest participation was observed in the students whose dorm rooms were located closest to the collection center. These reinforcements failed to achieve long term behavioural changes among the students (Brothers, Krantz and McClannahan, 1994). Brothers et al. (1994) investigated recycling behaviour of users in relation to the distance of bins in an academic building which consisted of offices, classrooms and copy rooms. This study showed that the provision of a central location for paper recycling significantly reduced the amount of paper in the general waste stream in the administrative (including reception, secretarial, bookkeeping, conference, and copy rooms), instructional areas (12 classrooms, dining room, and gym) and offices (offices, both private and shared, including 20 work spaces). Furthermore, when users were given desktop recycling trays for paper, paper in the general waste stream decreased further. The authors also obtained these measures for each of these areas for seven months after introduction of the desktop recycling trays. The mean percentage of paper recycled during follow-up was 92%.

Another significant finding of this study is the maintenance of the data despite new employee additions (who did not have previous information about local containers unlike the current employees) within the university. Information about recycling can be communicated through colleagues; however, the authors speculate that it is quite likely that local containers were relevant discriminative stimuli for recycling.

Similar to Brothers et al. (1994), Ludwig, Gray and Rowell also conducted studies in academic building in 1998 to show the influence of distance of bins on the recycling behaviour. During the baseline of their experiment, recycling containers were placed in a central location and moved to classrooms during the intervention / treatment period. Both building A and building B showed a significant increase in the percentage of daily beverage cans recycled. In Building A, during the baseline 40% of cans were placed in recyclables, 63% during the intervention and 40% during the withdrawal. In Building B, 35% of cans were placed in recyclables during the baseline, 65% cans during the intervention and 29% cans during the withdrawal period. During the intervention period, the percentage of daily recycled cans disposed in trash decreased. O'Connor, Lerman, Fritz and Hodde (2010) point out that even though previous experiments (such as Brothers et al., 1994 and Ludwig et al., 1998) suggest that recycling can be increased by moving the recycling bin closer to the user, these studies have an important limitation: they fail to control for the number of recycling receptacles available across conditions and paired these treatments with signs or memos to use recycling bins. It is therefore, unclear whether the location or the number of bins is affecting the increase in recycling behaviour. To investigate the effect of location of bins on the recycling behaviour, O'Connor et al. (2010), placed recycling bins outside the classrooms in the common areas, hallways, before placing them inside the classroom. Results showed no change in baseline levels of recycling. A significant increase in recycling in all three target areas was observed when recycling receptacles were located inside the classrooms (64%, 47% and 71% in Building A, Building B, and Building C respectively). The results of their study are in line with results of Ludwig et al. (1998) and conclude that location of recycling bins for classroom settings is critical in increasing the recycling behaviour in such settings.

A report published by the Packaging Consumer Awareness and Education Steering Group (PCAESG) in 1999 showed the positive influence of easy access on the recycling behaviour of the users. The report outlined that since the users had easy access to glass and paper recycling facilities, glass and paper were the most common recycled materials. Accessibility can also be increased by placing the bins at a location where they are clearly visible, i.e., without any visual obstacles and perhaps in high traffic areas. Sustainability Victoria (2007) observed that recyclables were not being disposed properly in the Food Court in the Queen Victoria Market (Melbourne, Australia). Another observation was that the waste bins in the Food Court were located in congested areas. Such poor location gave limited access to the cleaning staff and users during peak periods. To increase recycling of materials, bin locations were changed and they were placed in areas where food was consumed and at exit points. These bin locations were determined by consulting the Food Court staff to ensure that the areas in which they are located are regularly maintained and cleaned (Sustainability Victoria, 2007).

Another approach to make sorting convenient and easy is to provide special openings for lids of different streams and coloured waste receptacles. Specific lid openings can give information for what material goes in which bin. For example, paper bins with slit opening lids give cognitive clues to place paper in that bin. Some other suggested designs include round openings and round slots for containers and newspapers (Stantec Consulting Limited, 2009). Reducing the cognitive and motor demands for recycling (through specific lid openings) should decrease the amount of contaminants that enter the recycling stream and reduce the recyclables that are found in the general waste stream (Duffy and Verges, 2008). These lids can also serve as barriers and discourage users from placing recycling materials into the trash can, ultimately resulting in decreased overall contamination (Duffy and Verges, 2008). However, Duffy and Verges (2008) also suggest that the specific lid openings can also decrease recycling compliance as such lids raise demands for recycling. They argue that placing an object through a small hole or narrow slit requires guided action and cognitive effort which is not required when recycling materials are deposited into recycling containers with wide openings. Their study found that specialized lids actually increased compliance rate by 34% and reduced the amount of contaminants entering the recycling stream by 95%. Therefore, the use of

specialized lids for waste bins can be expected to increase recycling/sorting by the user. Waste bins with specific lid openings have become common in public spaces making users familiar with them. This means that the users may have developed a simplified heuristic (a process) to dispose waste (Duffy and Verges, 2008). According to this heuristic, specific lid openings are associated with recyclable disposal while receptacles without such opening are for trash. This default heuristic means that lack of specific openings for recyclables may lead users to dispose recyclables in the trash (Duffy and Verges, 2008).

Montazari, Gonzalez, Yoon and Papalambros (2012) investigated the effect of the colour of recycling bins on recycling behaviour of individuals. They hypothesized that if a recycling bin is highly visible and stands out relative to neighbouring objects, then it will draw attention and the user will be more likely to recycle. Using conditions of no visual cues and visual cues, Montazari et al. (2012) show that among red, green, blue and medium grey, green and red were the most and least memorable colours for both conditions (assuming size, accessibility, etc., equal) respectively. Furthermore, when the green recycling bin was placed with the grey trash can (high salience due to colour contrast), 88% of the subjects recycled. When the grey recycling can was placed next to grey trash can, marked only by signs (low salience), only 52% of subjects recycled (Montazari et al., 2012).

Signage posted around the waste bins can also make the sorting behaviour easy and convenient by providing information on what items goes in which stream. Increase in the recyclable material in the recyclable container and decreased recyclable materials in the trash can were observed by Austin, Hatfield, Grindle and Bailey (1993) when they posted prompts over each bin, which described what material belonged in which bin. The effectiveness of these signs increases when they are prominently displayed (on or above the waste bins) as it decreases the likelihood of users ignoring these signs, thereby increasing the sorting behaviour. Signage that uses only words may pose a barrier for sorting behaviour for non-native speakers of the language. However, pictures of the items that are suitable for disposal in each waste bin, in addition to the written instructions may become more effective. Such additions become important in university settings where

students from other provinces and countries are part of the population. These limitations may result in the default heuristic (Gigerenzer, 2008) of disposal of garbage (trash or recyclable) into the trashcan (Duffy and Verges, 2008). Therefore, design of the signs becomes crucial to increase diversion. Stantec Consulting Limited (2009) suggests a combination of graphics (photographs and realistic images) and text on the waste bins for increased diversion. The graphic grabs the attention of the user while the text provides confirmation of the correct material category (Stantec Consulting Limited, 2009). Utilizing user familiar symbols such as the mobius loop helps in effective signage.

Werner, Rhodes and Partain (1998) test the effectiveness of signs based on schema processing principles in a university cafeteria. These authors describe schema as "general term for a variety of memory structures that lead people to expect or see or experience certain things in certain settings". The university had recently switched to polystyrene cutlery and dishes, and wanted students to recycle the polystyrene dishes by scraping off the food from the plates. Despite the provision of large recycling containers, information brochures, and posting instructional signs, patrons (students, staff and faculty) did not participate. In addition, when these plates were placed in the recycling container, they were contaminated with food particles. Werner et al. (1998) observed that the signs were too small and low to be seen from a distance. The signs contained too much information to be processed by the users in the small amount of time that they were willing to devote to the activity of garbage disposal. The signs did not give the users specific instructions on how to recycle and what steps needed to be followed in order to recycle (i.e. scrape off food). Also, the sign did not mention what recyclables could be placed in the recycling bin which led to contamination. The authors designed new signs that were large enough to be seen from a distance, distinguished polystyrene from other recyclables and gave clear instructions to scrape food from the plates. Such improvements showed increase in the volume of recyclables from 0.25 to 3.5 bins recycled per day and cleanliness, from major contamination to none. With the improved signage, weight increased by 87% and cleanliness scores improved by 43% (Werner et al., 1998).

Stantec Consulting Limited (2009) suggests placing the signs on the front, tops and sides of the bins that is accessible to the user. They also suggest placing overhead signs with

standardization helps deliver a consistent message and helps to increase the visibility of the waste. Attardo et al. (2001) evaluate the recycling program on the rest stops along highways in California, Ohio and Wisconsin. They showed that clear identification of recyclable bins with signs that specify what item goes where, decreased contamination. Signs were also placed on highways and other highly visible areas informing the public that recycling bins were located on rest stops. Attardo et al. (2001) recommend that the receptacle colours/signs should be consistent with popular practice in the region so that people are able to recognize bins/streams, ultimately leading to less contamination. Sustainability Victoria observed that the confusing signage in the Deli Lane Outdoor café in the Queen Victoria Market (Melbourne, Australia) rendered high contamination for waste streams (Sustainability Victoria, 2007). The addition of Sustainability Victoria standard signage for the bins and the familiar colour coding and symbols made it easy for the user to distinguish between each bin. This led to improvement of contamination rates (Sustainability Victoria, 2007). In their study at the Killam Library at Dalhousie University, Robinson et al. (2012) investigated the influence of signs and labels on the contamination of the solid waste streams of paper, recyclables, organics and garbage. A survey administered by the researchers showed that 50% of student respondents stated confusion and uncertainty regarding which item goes where as the largest obstacle to proper waste disposal. The most common recommendation or suggestion by respondents was to eliminate confusion regarding waste disposal by placing informative labels and signs around the four-bin stations (Robinson et al., 2012). When additional labels were placed above the four-bin systems, an overall improvement of 19.34% in waste diversion was observed (Robinson et al., 2012). The organics stream in particular showed the most significant change in contamination rates. After the signage was added, the contamination decreased from 25% to approximately 3%. The surveys and waste audits also showed that the most problematic items for disposal were coffee cups, soiled paper, granola wrappers, liquid waste, wax paper, water bottles, liquid waste and milk containers (Robinson et al., 2012).

In her study of employee behaviour in Dalhousie kitchens, Maguire (2012) highlighted contamination of garbage bins by food napkins and paper towels as a recurring theme in her kitchen tours and interviews with the employees of Sheriff Hall (one of the residences

on campus). Her conversation with employees showed that they had different opinions on which item should go what stream, as two employees thought that the food napkins go in garbage while another participant indicated that it goes in compost. Interestingly, this participant also stated that another employee does not believe that the food napkins and paper towels go in the compost and will take them out of the compost and put them in the garbage (Maguire, 2012). This study showed that there is limited knowledge about recycling clean vs. dirty plastic containers and saran wraps. Even though some employees knew that saran wrap and plastic containers are recyclable, if they were unwashed they were placed in the garbage bin (Maguire, 2012). Tours of the dining hall in Sherriff Hall showed that the compost bin was smaller than the garbage bin (Figure 2). This means that it will fill up more quickly with the food napkins which would discourage people from using the compost bin. Moreover, discussion with the Aramark staff indicated that there are not many waste materials generated for the garbage stream. Overbinning with small black bins at various locations was also noticed. Although signs for compost included soiled napkins, soiled paper and food waste, Maguire's findings suggest that the signs need to be more conspicuous. Perhaps, signs with pictures closer to the bins or on the bin will be more effective. The food preparation area (back kitchens) was also toured. Currently, employees have a plastic container at their workstation which is used to carry the food waste to the green cart. For convenience, a green cart from outside is brought in the back kitchen area. Signs reminding employees that food soiled napkins go in the compost near their workstation may also be effective. Additional information on these issues would help to increase diversion rates and help Dalhousie reach its goal of 75% diversion.

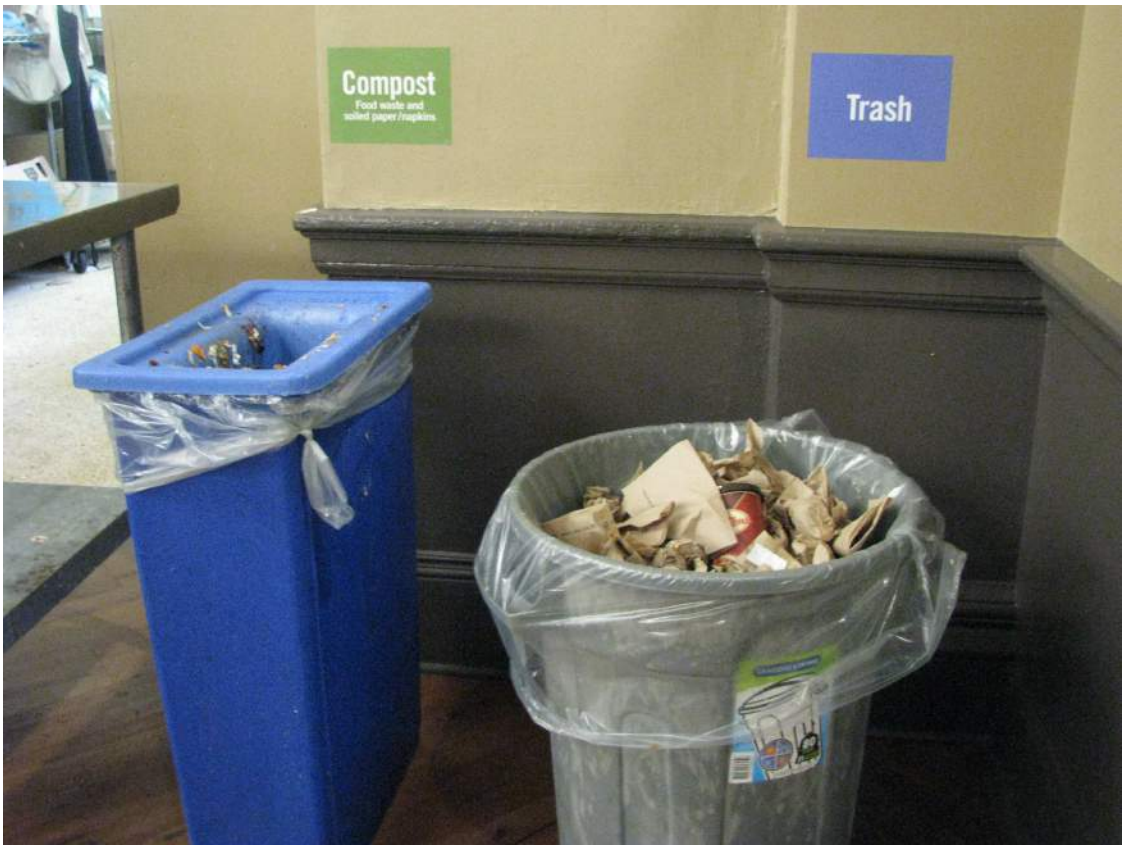

Figure 2: Bin System in Sheriff Dining Hall, Dalhousie University, Halifax, NS

Even though the appearance of the bins may not directly affect the recycling behaviour, the aesthetic qualities of the bins can attract the user towards the bins. Binder (2012) investigates the effect of replacing single dispersed trash and recycling cans in an academic setting with integrated waste and recycling bins. Before the new system was introduced, all floors of the academic building had multiple groups of trash and recycling receptacles in each hallway and common areas with no signage (Binder, 2012). The offices and classrooms in the academic building had a garbage can and paper recycling can. Each floor of the building experienced baseline conditions for four months. The treatment was applied to floor 1 and floor 2 of the academic building while floor 3 and 4 were used as control. After seven data collection sessions, another bin system was added to the floor 2. During the treatment the recycling/trash cans were removed and multifunctional recycling/trash bins were placed near the central entrance or stairway areas of the two floors with new signage. The colours of the new signage corresponded with the old bins; the signs were based on the principles outlined by Werner et al., 1998).

The treatment also included removing the trash and recycling bins from the classrooms. Posters and signs directing the students to use the hallway bins for waste disposal were posted. Results of the study show that compared to the baseline, percentage of recycling placed in garbage can on floor 1 and 2 decreased when the intervention package was implemented. Recyclable materials are broken down into paper/cardboard and plastic/glass/recyclables. Increases in the weight of plastic/glass/recyclables accurately sorted in the recyclable bin were greater on floor 1 and floor 2 after treatment than floor 3 and floor 4. The daily weight of waste decreased significantly on floor 1 and floor 2 after the implementation of the intervention. A social satisfaction survey was also conducted as part of the study. Results of the survey showed that these new bins were liked by the students in the university and believed that they made it easier to sort their waste. The response to the question regarding the likelihood of leaving waste behind in the classroom showed mixed results. 26% agreed or strongly agreed with the statement 'Because of the new waste receptacles, I am more likely to leave litter in classrooms or other work areas.' 62% of the participants disagreed or strongly disagreed with this statement.

In this study, most of the plastic/glass/metal waste was generated in the classrooms. However, classrooms were not provided with a bin for these containers; they only had containers for paper recycling and black garbage. This baseline situation for the classrooms presented an increased response cost of accurate disposal of plastic/glass/metal waste as the students needed to carry their waste past a garbage bin into the hallway (Binder, 2012). During the intervention phase on Floor 1 and Floor 2, students were forced to bring all of their waste outside and sort it at one location. This resulted in a reduction of the response cost of accurate waste sorting as the disposal options for all waste streams are presented in close proximity. Binder (2012) suggests that this reduction contributed to the increase in accurately sorted material.

A study conducted at Dalhousie University investigated the effect of improved bin placement and signage on the contamination rates of solid waste streams in classrooms and lobbies in two academic buildings (Computer Science Building and Chemistry Building). (Arany et al., 2012). Arany et al. (2012) removed the black bins from the

classrooms and placed signs instructing the students to take their waste materials outside in the hallway. In one of the buildings, the waste bins were hidden behind chairs, thereby reducing their visibility. They removed these bins and placed them where they were easily visible. Such small but effective changes showed decease in the contamination rates, particularly in the recycling and garbage streams. Before these changes, only 26% of the contents in the garbage stream were correctly placed. After the implementation; however, it rose to 44% (Arany et al., 2012). Waste audits conducted by Arany et al. (2012) showed that both the classroom and lobby of the Computer Science Building showed decreased contamination. The recyclables stream showed the most improvements. Other significant findings of this study are the results of the survey that were administered to students and custodial staff. 58% of the student respondents stated that they are often unsure about what waste material goes where, which identifies the need for education. Both student and staff recommended improvements for signage and increasing the number of bins. Improvements for office waste disposal were also recommended by the custodial staff.

2.2 Lab Waste Management

As an academic institution with research facilities, Dalhousie University generates large amounts of laboratory wastes. According to a report completed by the Office of Sustainability in 2011, there are 2455 laboratories in the three Halifax campuses (Brady and Jorgensen, 2011). It also concluded that there is inconsistency with disposal of plastic and glass bottles that previously contained hazardous materials. Biagi et al. (2011) conducted a study in the Introductory Biochemistry teaching laboratory 2610 at Dalhousie University and determined that the majority of waste produced went to landfills with almost none being recycled. Inconsistency with the bin systems in labs was observed when photographs of these systems were taken in Life Sciences Building labs. Similar situations were reported in the Biochemistry labs by Cuirlia (2012). Brady and Jorgensen (2011) report that many labs do not have a recycling bin. The scope of this study, however, does not include lab waste and its management at Dalhousie due to the nature of the waste generated in labs and the time constraints for the project.

2.3 Summary

The Theory of Planned Behaviour postulates attitudes, subjective norm and perceived behavioural control to be the factors that affect behaviour. Perceived behavioural control can also be explained in terms of convenience of a behaviour. The positive influence of convenience on recycling has been documented in various settings: in the context of the theory (Boldero 1995; Davies, Foxhall and Pallister, 2002; Tonglet et al., 2004), in relation to the location of bins (Gonzalez-Torre and Adenso-Diaz, 2004; Humphrey et al., 1977; Brothers et al., 1994; Ludwig et al., 1998) and their accessibility (PCAESG, 1999; Sustainability Victoria, 2007). Studies have highlighted the importance of specific lid openings for different waste streams (Duffy and Verges, 2008), colour – coded bins and their proper placement (Montazari et al., 2012, Attardo et al., 2001) to encourage recycling behaviour among users. Studies related to recycling have also shown the importance of signage for increase recycling behaviour (Austin et al., 1993; Werner et al., 1998; Attardo et al., 2001, Sustainability Victoria, 2007; Robinson et al., 2012). Aesthetically pleasing bins may also encourage recycling behaviour (Binder, 2012).

2.4 Importance of study

Research into recycling has helped to establish the basic guidelines of user recycling behaviour: closely located bins, easily accessible, colour coded with specific lid openings, and clear signage. Extensive research into the implementation of bin systems standards for particular space types; however, has not been conducted. This study examines this connection in-depth and thus will assist in the application of campus-wide standards. Space types include classrooms, auditoriums, offices, meeting rooms, hallways, kitchens dining halls, residence recycling rooms, offices along with classrooms, hallways and meeting rooms. The study compares the recycling/sorting behaviour of the users in various space types before and after a new bin system is implemented. The results of this study aim to determine an effective bin system for particular space types. While previous studies have focussed mainly on the user, this study incorporates the perspectives of the custodial staff as well as the user.

In context of Dalhousie University, the four bin system of Paper, Recyclables, Organics, Garbage (PROG) has been placed in areas of high traffic and visibility. In addition to the four bins, overbinning with single black bins continues to be a challenge to increase diversion. These black bins not only contribute to the high contamination rate but also require frequent collection by the custodial staff. Replacement of these bins with a standard bin design would help save time and resources of Facilities Management and help Dalhousie achieve its goal of 75% diversion.

Support for this study was also reported in the Annual Sustainability and Transportation Survey (Office of Sustainability, Dalhousie University, 2013). Respondent suggestions included limiting the access to garbage bins, making the compost bins more accessible, rectifying the lack of signage, proving more bins for non-refundable recyclables, and having more sorting stations at campus. Lack of compost bins and not having the option to sort were most common problems that were reported for waste sorting at Dalhousie. A few comments also indicated the need for standardized bins and standardized signage "…so that people learn the system and are able to use it". One respondent pointed out that Dalhousie has all sorts of bins with different sizes in hallways, therefore standardized bins are needed.

3.0 Objectives

Dalhousie manages seven waste streams as outlined in its material categorization guide (Office of Sustainability| Dalhousie University, 2013):

1. Paper and Cardboard
2. Organic: Food, Yard and Farm
3. Recyclables (plastic, glass, metal)
4. Construction and Demolition Waste
5. Hazardous: Nine Classes
6. Universal: products with some toxins such as electronic waste and batteries
7. Composite and Miscellaneous Waste

Paper and Cardboard, Organic, Recyclables and Garbage (Composite and Miscellaneous Waste) steams are the focus of this project. Four bin sorting stations for Paper,

Recyclables, Organics and Garbage have been placed in hallways and areas of high traffic. Despite the system's application all over campus, presence of single black bins continues to contribute to the high contamination rates (Office of Sustainability| Dalhousie University, n.d.). One suggested way to increase proper sorting is to provide waste bin standards for these four streams that are specifically designed for a space by taking factors such as physical layout, occupant behaviour, and type of waste generated into consideration. These standards will contain information about the bin system or the type of bins for identified spaces, including coloured and shaped tops, the order of the bins, their size and location, and the style and placement of signage. The hypothesis is that the implementation of these standard designs will lower the contamination rates. For the purpose of designing a waste bin standard, nine spaces were initially identified:

1. Offices
2. Hallways
3. Classrooms / Auditoriums
4. Residence Recycling Rooms
5. Front Dining area (Residence)
6. Commercial Kitchens (Residences)
7. Kitchenettes in buildings (outside of residences)

In particular, the following research questions were investigated:

1. What waste bin standards supports improved sorting behaviour in specific areas?
2. What is the optimal distance for bins placement for increasing waste diversion?

4.0 Methods

Methods for this study include two focus groups with custodial supervisors and staff at the Halifax Campus, interviews with kitchen staff at the Truro and Halifax Campus and waste audits at the Halifax campuses.

4.1 Focus groups

In order to evaluate the proposed designs for their practicality and effectiveness, feedback on the proposed designs was sought from the university custodial staff. Custodians interact with bins and are most aware of the on-ground challenges of the current bins, and can provide suggestions to improve the proposed designs. Focus groups with custodial supervisors and staff were conducted on June 17th and June 18th, 2013 respectively. During these focus groups, proposed designs for offices, hallways, meeting rooms, classrooms/auditoriums and laboratories (teaching and research) were shown. Participants were asked to comment on the challenges and benefits of the proposed designs and suggest improvements (Appendix A– Focus group questions). Focus group discussions related to lab waste \showed that due to the nature of waste generated in labs implementing the bin standard in labs is a complex process. Therefore, given the time constraints of the project, laboratory space types was not included in the current study. Focus group discussions for laboratory wastes are, however, included in the results section.

4.2 Interviews with kitchen staff

Dalhousie kitchens are an important space to consider for waste diversion as they generate large quantities of organic waste. Commercial kitchens across Dalhousie have varying physical layouts and space. Creating waste bin standards for kitchens is more challenging than other spaces because most kitchens have limited space for waste bins. Therefore, kitchen staff at the Truro and Halifax campus (Sheriff Hall) were interviewed to get insights into their current waste management practices and get their feedback on some suggested improvements Appendix B - Interview questions). Pictures of the waste bins in the kitchens were also taken during the interviews.

4.3 Waste Audits

4.3.1 Test of waste audit methodology

A test of waste audit methodology was undertaken in March 2013 to identify modifications before auditing took place. Bags (Paper, Recyclables, Organics and Garbage) were collected from hallways, classrooms, and meeting room from the Life Sciences (LSC) building. Type 3 waste audit method (Individual bag & sub-categorization auditing) as described by Office of Sustainability in its Waste Audit Procedures guideline (2011) was used. Waste baskets were used for the audit. Before weighing the contents of bag, the weight of the waste basket was recorded. Then each bag was opened and emptied in the waste basket. Weight of the contents in grams (without the bag) was recorded. A visual inspection of the bag contents was followed by pictures. Notes about the composition of contamination were also taken. Weight of contamination for each bag was recorded in grams. The contamination was then sorted into streams of paper, recyclables, organics and garbage. Items not belonging to the stream were identified and separated (contamination). Weight of the contamination was recorded in grams. The contamination was sorted into the streams of paper, recyclables, organics and garbage and weighed for each stream (in grams). The data was then input into MS Excel for calculating the % contamination for each location. Visual graphs representing this data were also created in MS Excel.

The waste audit conducted in March showed that the bags had fewer quantities of waste than expected and some rooms had no materials. At the time that the bags were collected, the timing of the bag collection was unknown. The time of the collection can have a major impact on the quantity of waste generated. Therefore, waste generation should be monitored for a period of time so that representative waste samples can be collected. Connecting with custodial staff to coordinate pick up times to represent a full day's waste is essential. Such results will help to design better bins and signage to promote diversion from users.

Some other limiting factors were identified. The scale used during the audit supported weights to be recorded in kilograms or pounds. The scale is connected to a laptop as a

source of power. Hibernation of the laptop would cause the scale to switch off. This caused some inconvenience and some discrepancy with the results as switching between the kilograms and pounds may have taken place during the auditing process, when the machines were switched on after hibernation. This procedure highlighted the importance of timing, duration, and frequency of the waste collection for the project. Some of the outcomes of this test audit were to initiate discussions with the Facilities Management personnel to make arrangements for the researcher to collect bags if possible. Careful consideration was given to an electronic scale not connected to a laptop for the audit procedure to provide convenience and consistency in the results.

4.3.2 Audits before the changes were applied

For choosing locations for the audits, feedback from the custodial supervisors was sought. Locations for each space type and the required changes to implement the standard were discussed. In the meeting, various locations were identified as areas of special consideration. The supervisors highlighted that implementing the standard in these areas will be challenging due to high traffic and large volumes of waste generated. The implementation of the standard and the subsequent removal of black bins may cause problems with waste management in these areas. Implementation of standards in these areas requires more time to study the waste generation patterns and make the required changes. As auditorium space types were identified as a special area, these were not included in the study. Due to the varied usage of meeting rooms, an alternate location of lunch room was used. Kitchen and dinning areas were not included in the study due to timelines of the project. Table 1 shows the selected locations for space types. Waste from classrooms, hallways, offices and residences was collected on 22nd, 23rd, and 24th October, 2013. To sort the waste, Type 3 waste audit method (Individual bag & sub-categorization auditing) as described by Office of Sustainability in its Waste Audit Procedures guideline (2011) was used.

Table 1. Space types for the study and the chosen locations within Dalhousie University

Space Type	**Location**
Classrooms	6 classrooms in Marion McCain Arts & Social Sciences Building; one large classroom in Mona Campbell Building
Hallways	Life Sciences Building; Marion McCain Arts & Social Sciences Building; Kenneth C. Rowe Building
Offices	Offices in Weldon Law Building
Residences	Recycling Room, 3 rd floor, Risley Hall
Lunch Room	2nd floor, Central Services Building

4.3.3 Changes applied

Based on the guidelines and concepts illustrated in the literature review, a guidelines standards document was created and changes to the existing waste system were applied to some locations within the Halifax campus using these standards. New eye-level signage following the HRM sorting guide was designed along with a *Pack it in Pack it Out* sign by Dalhousie Communications and Marketing and external illustrator. Single use garbage bins were removed from classrooms from the McCain building and a *Pack it in Pack it Out* sign directing people to take their waste outside in the hallway was installed (Figure 3). In order to compensate for the removal of garbage bins, two four bin systems were installed in the hallways near the classrooms. New signage including pictures was installed above the already present system of four bins in the McCain building.

Figure 3: Pack it in Pack it out sign for classrooms

Single use garbage bins were removed from classroom in Mona Campbell building and a smaller four bin system, along with new signage was installed in the classroom. New bins were installed in the hallways in the Life Sciences Building. Old bins were removed from the 3rd floor, Risley residence and new bins and signage were installed. Signs for broken glass and cardboard were also created and installed. Despite contamination in the offices, the implementation of changes to the offices was difficult as it was revealed during the focus groups that office residents needed to buy their own garbage bins. This was a limiting factor in the implementation of the office design. Pre-audits of the Rowe building hallway bins did not show contamination of the streams. Therefore, changes were not applied to this location. Communication with custodial supervisor indicated that removing single use garbage bins from the lunch room would leave lots of garbage in the lunch room between breaks since the lunch room is cleaned only once. Following this advice, a sign directing people to take their waste out was implemented; however, the single use garbage bin was not removed. Table 2 shows the location and changes applied to each location at the Halifax campuses.

Table 2. Locations chosen and the changes applied

Location	**Before**	**After**
McCain Classrooms	Single – use garbage bin	Remove garbage bin & put sign to take waste out
McCain Hallways	Four bin system without any picture signage	Addition of new signage with pictures; addition of two new four bin systems (PROG) with colour coded lids, special openings & new signage with pictures
Mona Campbell	Single – use garbage bin	Small four bin system (PROG) with colour coded lids, special openings & new signage including pictures
Residence Recycling Room, 3rd floor Risley Hall	Bins not colour-coded, no bins for recyclables, inconsistent signage	New five bin system (PROG + Refundables) with colour coded lids, special openings & new signage with pictures
Lunch Room, 2nd floor, Central Services Building	Single – use garbage bin	Sign to take waste out; did not take out the waste container

4.3.4 Audits after the changes were applied

After the changes were applied, waste was collected from McCain Hallways and Mona Campbell buildings on 19th, 21st and 22nd November. Waste was collected from 3rd floor of Risley Hall on 19th, 20th and 21st November. Waste from the Lunch Room was 26th, 27th and 28th November. Waste was sorted using Type 3 waste audit method (Individual bag & sub-categorization auditing) as described by Office of Sustainability in its Waste Audit Procedures guideline (2011).

5.0 Results

5.1 Focus Groups

Two focus groups with custodial supervisors and working foreman were conducted on July 17th, 2013 and July 18th, 2013 respectively. Each focus group had six participants. Participants were shown current and proposed designs for the space types. The main objective of these focus groups was to get feedback from the custodial staff about the challenges and benefits of the proposed designs and improvements on the proposed designs.

Barriers to waste sorting

Both focus groups quoted lack of knowledge or education as the major barrier to proper material sorting by students and employees. Another barrier highlighted was that many students who are from outside HRM or Nova Scotia are unfamiliar with the waste sorting system at Dalhousie. Other barriers included confusion with mixed materials which are difficult to categorize in the streams of Paper, Recyclables, Organics and Garbage (for e.g., paper with plastic, other plastic items, cardboard, boxboard). Focus group participants mentioned that people leave waste materials in classrooms and expect the custodial staff to take care of it because they think that custodians know what to do with it. It was also highlighted that Dalhousie University is used by many outside groups. Lack of clear communication to these groups about the waste sorting system can lead to improper sorting of waste items in streams.

Most contaminated streams

Focus group responses indicated that the pop cans and bottles were commonly found in garbage cans in classrooms. Confusing signage regarding the recycling bins on campus was mentioned with regards to contamination in the bins. Responses from the custodial staff indicated that the organics bin was the most contaminated stream. Contaminants in this stream included take-out containers and TV dinners. Another major theme was contamination in the organics makes sorting less desirable, difficult, and safety hazard for custodians because it is hard to see what is inside the bin.

Improvements

Better signage, clear communication and education were some major improvements suggested. In particular, the focus group participants suggested the need for communication about how to recycle pizza boxes and boxboard. One of the participants highlighted that pizza boxes are a major problem at the campus because of unclear communication between the waste haulers and Dalhousie custodial staff. The waste haulers often don't agree with the custodial staff on the acceptability of soiled pizza boxes in the compost or corrugated cardboard stream. Other improvements suggested were more locations, more information on the website, and creation of an app for waste sorting by the custodial supervisors. More user responsibility for waste disposal and more education were suggested. Other themes included problems with sorting the contaminated organic stream, its safety implications and the large amount of e-waste in the residences.

Offices

Both focus groups were asked for their thoughts on the proposed design for offices (Figure 4). Some offices at the Halifax campus have adopted this proposed design but it has not been implemented systematically across the campus. During the focus groups it was learned that people in offices needed to buy their own garbage can. One of the participants added that even though people use the proposed bins, they often function as containers to hold stationary, etc. since people don't want to give up their garbage bins because they paid for them. This poses a challenge to the proposed mandatory implementation of the design across the campus. Discussions regarding the improvements for the proposed design included addition of a compost side saddle (in addition to the

recycling side saddle). However, a group consensus was reached to not add these as “the idea is to get a big compost load” in main hallway bins and reduce the office holding of organics that may lead to pest problems. Other themes discussed included people’s resistance to change and the need to provide fire resistant bins for all locations. As discussed in the focus groups, most distribution companies now have fire resistant bins. Therefore, this will not be an issue/challenge for the designs. Compliancy issues such as organics in black bin with the design were also mentioned. Another participant mentioned that the office residents may still expect the custodial staff to clear these small baskets out if this is not communicated otherwise. This observation presents another challenge for the design – clear communication for the office residents. Another key theme brought up in this focus group was dumping of coffee and other liquids in black bags. It was mentioned that even though sorting may be an issue, users have become more aware of waste sorting in the offices. Savings in bags was discussed as a benefit to the design.

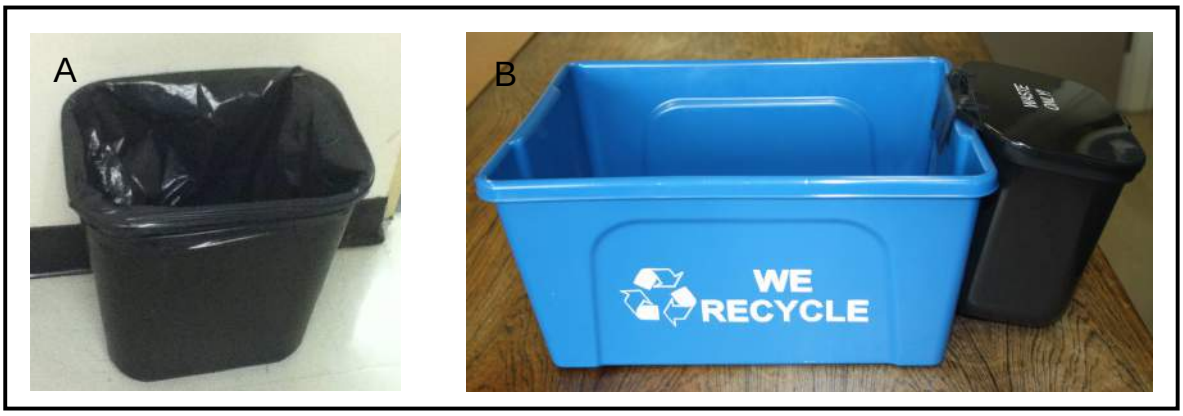

Figure 4: Current (A) and proposed design (B) for offices

Hallways

The proposed hallway designs included some modifications to the current design and one new design (Figure 5). Modifications to the current design included addition of signage with pictures at eye level. The location of the signage with pictures was a common theme in both focus groups. With regards to signage in hallways, it was suggested that it should be above the bins where “it is really quick to look at, it is at eye level” and “… it doesn't slow them down and get visual cues”. Participants also liked the idea of pictures as it removes the language barrier for users as the Dalhousie community consists of students,

staff and faculty from various nations across the world. Participants in both focus groups indicated that there may be some bins where such a sign above the bins may not be possible due to their location under a window or artwork. Participants short listed some key locations where such signage with pictures would be beneficial to waste sorting:

- Hallways
- Main thoroughfares
- Cafeterias
- Large Lunchrooms
- Student Union Building
- Near first year locations
- Front of Rowe building, McCain
- Main food generating areas
- The library

Missing bins in residence was mentioned by both focus group participants and may pose a challenge for implementing a standard. Since HRM has updated their recycling program to include all plastic containers from #1 to #7, signage around campus needs to be updated. A 'phase-in period' for this signage update was suggested in the focus group discussions. The appropriate bin size for organics was also discussed. One participant pointed out that the current bin size fits the bag size quite well and changing the size of the bin may require looking for a new sized bag as well. This can be a potential challenge. Since the organics bins were oversized, there was much discussion about whether to use bags inside the organics bin. This idea was suggested as a way to reduce waste because bags in organic bins are emptied even when there is little food waste. The smell of the organic waste, and mice were listed as reasons for the bags to be collected. In relation to this issue, group consensus was reached that they liked the bags within the organics bin. The challenges and benefits of clear bags for garbage were also discussed. Benefits included safety as the staff can see the contents of the bag, and handle the bag accordingly. One participant pointed out that while training, the staff is told to take only the black bags in the labs. They do not handle the clear bags. If clear garbage bags are implemented in labs, then it will be difficult to train the staff, especially in a multinational staff community where a language barrier may exist. Quoting one participant "…*I like*

black [bag] at the same time, I know we can't see the dangers in it, but at the same time, we are going to trust that there is nothing hazardous in there 'cause we don't wanna know if you just threw out something scary."

Another suggestion regarding bags in labs was that they could be frosted grey or bluish green.

Figure 6: Current designs (A) and proposed designs (B) for hallways including addition of new signage and installation of new bins

Meeting rooms

The challenges and benefits of the proposed designs were also discussed in the focus groups (Figure 6). In particular, the appropriate location, bin size, and the criteria for placing the bins or signs was discussed. The focus group participants suggested that if there are multiple users of a meeting room then placing four bins inside the meeting room would be more appropriate. High usage and catering for meeting rooms were decided as

criteria for installing the bins inside meeting rooms. Reasons to put bins inside the meeting rooms included convenient location, and people walking out from a long meeting "*are not going to make special trips to the hallway to put their garbage.*" One participant pointed out that in one of the more frequently used rooms, students left the garbage on the table even though there was a four-bin sorting station outside the classroom in the hallway. There were no garbage cans inside the classroom. Therefore, signs may be ineffective in such a setting. Some other suggested designs included portable carts which can be placed in a meeting room when a catered meeting was taking place. However, several challenges to this design were brought up by the participants, mainly responsibility of moving the carts, custodials not knowing if a meeting is taking place, and the need for permanent hallway bins. Discussions about whether to put a bag in the small bins in meeting rooms indicated a group consensus for putting bags in the small bins, mainly due to time factors for cleaning the bins in the absence of bags. To quote one participant, "*If there is no bag there, your chances of actually getting it cleaned out on a regular basis, that's just whole another ballgame.*" Responsibility of Catering Services for food waste in meetings was also discussed.

Figure 5: Current (A) and proposed designs (B) for meeting rooms including the sign for small meeting rooms and the four-bin system for large, frequently used meeting rooms with catering

Classrooms and Auditoriums

Figure 7 and 8 show the current and proposed designs for classrooms and auditoriums respectively. Both focus groups participants pointed out the problem of garbage on the desk or on the floor in classrooms and auditoriums. The location of the bins in the auditoriums was also a problem. To quote one participant, "*When the class lets out, a large number of students [lets out] in all of those classes. So, [if] somebody wants to stop to use the sorting station, they are in the way of the person behind them… stopping traffic*." Other comments related to the location of the bins suggested that the bins need to be placed conveniently. Another participant added that the traffic flow of students in auditoriums is not one way. While some students exit from the hallway (where the bins are placed), the other half exists from the other doors where there no bin system present. These comments show that the bins inside the auditoriums need to be changed so that it is easy for people to sort waste. One of the other participants noted that the bins need to be placed in a way that they are not too close to the door. The capacity of the room was decided as the criteria for placing the bins inside the classroom/auditoriums. Large capacity seating and the number of classes in auditoriums were listed as reasons for placing bins inside the auditoriums. Participants suggested to start with smaller bin sizes and then if they fill quickly change the bins size accordingly.

Figure 6: Current (A) and proposed designs (B) for classrooms including a sign to take waste out for small classrooms and four-bin system for large classrooms

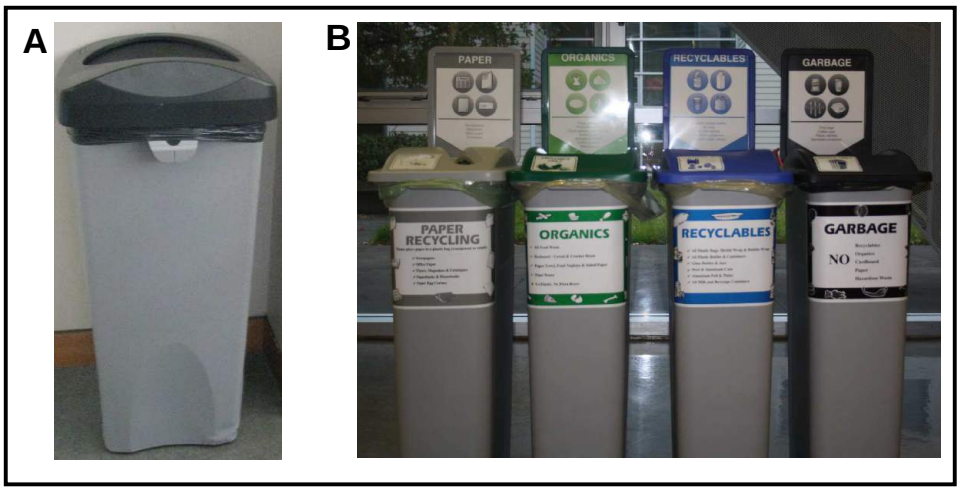

Figure 7: Current (A) and proposed designs (B) for auditoriums

Laboratory – teaching and research

Staff safety while handling lab waste was major point of discussion during both focus groups. Discussions related to safety included accidents with hazardous chemicals and sharps. Both highlighted problems with enforcement of lab practices such as rinsing chemical bottles and dumping hazardous materials in black bags. The participants indicated that there may be a communication issue in the labs as sometimes there are "*problems on days where different graduate students in lab; it has to be the responsibility of the researcher*." They also indicated that sometimes new students are unfamiliar with the process and throw hazardous materials or sharps in the black bag. One participant from the staff focus group indicated that "*Facilities Management [has] standard on what is sharp but the Faculty of Medicine has a completely different standard on what is sharp*." Another common theme was the unknown substances used in a lab setting. "*There's some pretty innocuous stuff that's harmless but it smells really really strong and we've run into that, something in the garbage smells really really strong then it takes three months with the safety office involved to get to the root of what was dumped to find out yeah it was okay, we could have removed it. …eliminate where we want to play any guessing games. Is it harmful, is not harmful. It smells bad, but is it bad.*" One participant even suggested that waste from labs should not be collected and that the lab users should take care of it themselves. The idea of lab waste managers was also put forward. It was

learnt that pipettes are put in a cardboard box because transporting them in bags may become a safety hazard for the staff. For bio-hazard wastes, a sticker is provided by the Health and Safety Office. The participants indicated that this sticker is easy to miss and the staff need to be extra careful. "*…and… look for the sticker. So, you almost have to know where it is in the lab*." Participants also highlighted that not having a black garbage bin nearby may pose safety hazards. The lack of space constraints in both old and new labs was also pointed out. This observation is relevant for implementing a bin standard for labs. As one participant said, "*Newly renovated labs in Tupper, they still don't have a lot of room, you're going to get seven containers, and most of them don't even pay attention…"* Table 3 outlines some themes that emerged from the focus group discussions.

Table 3. Themes from the Focus Group with custodial supervisors and staff

Question / Location	Themes during focus group
Barriers to sorting	Lack of education
	Outside city/province students confused about sorting at Dalhousie
	Mixed materials are difficult to sort
Contaminated streams	Garbage
	Recycling
	Organics
Improvements	Better and consistent signage
	Clear communication, especially about recycling of pizza boxes
	Education about waste sorting at campus
	User responsibility for waste sorting and disposal
	Better information for students regarding E-waste disposal in residences
Offices	People bought their own garbage bins in offices & did not want to give up their bins; challenge for implementation of office design
	Clear communication about user and custodial responsibility
	Significant savings in bags as the office design does not require any bags discussed as a benefit

Hallways	Signage with pictures were liked as they reduced confusion and removed the language barrier
	Key locations for signage with pictures and new bins for hallways were suggested
	Phase-in period for updating the recyclables signage
	Bins for organics were oversized in hallways
	Bags were used in bins as they made the bins easy to clean and maintain
	Mixed response for clear bags for garbage at the Halifax campus
Meeting Rooms	Frequently used and catering applications were discussed as criteria for putting the bins inside the meeting room
	Using bags in bins as they made the bins easy to clean and maintain
	Change in cost of bags from buying larger bags to smaller bags
Classrooms and Auditoriums	Bins too close to exit; bin location should be convenient and not stop the flow of traffic
	Classrooms and auditoriums with large seating capacity should have bins inside the room
	For smaller classrooms, signs to take waste out can be used
Laboratories	Staff safety was primary concern when handling wastes from labs
	Hazardous materials & sharps in black bags; major concern for wastes from lab settings
	Waste disposal practices need to be better enforced
	Communication between supervisor and lab users needs to improve
	Lab waste managers to handle waste from labs were suggested to decrease the risk involved for the custodial staff
	Clear bags for garbage in labs not favoured as custodial are trained only to pick up the black bags. The clear bags are used for bio-hazardous wastes.
	Lack of space in labs will be a challenge for waste bin design

5.2 Interviews

Kitchen staff from the Agricultural Campus and Sheriff Hall at the Halifax Campus were interviewed on 6th August, 2013 and 28th August respectively. Two kitchen staff at the Agricultural Campus and one staff member at the Sheriff Hall were interviewed. Staff at both locations were asked questions regarding waste sorting and general waste management in the kitchens.

Agricultural Campus

Chartwells is the food provider at the Agricultural Campus. Chartwells uses the "Trim Track" program to weight the waste. Each workstation has a small plastic container with markings to measure the organic waste that gets thrown out. When these containers are full, the waste weight is recorded and the container is emptied into the green cart. Green carts are kept in a separate refrigerated room. The respondents also indicated that having a compost bin inside the kitchen is undesirable because of the smell and flies. It was indicated that such additions would be unnecessary as the staff do not have any problems with the current location of the bins. There were four garbage bins in the kitchen at the end of each work table. The main garbage generated from the kitchen was dirty saran wrap. The bins are washed regularly; therefore, paper stickers are not desirable. The respondents also indicated that the bins are moved around the kitchen, therefore signage on the bins would be more desirable, rather than on the wall. The lack of colour-coded bins was observed; however, this was not reported to be a problem with staff. Most staff in the kitchen is full-time and has been working in the kitchen for long periods of time. Therefore, they are familiar with the layout of the bins and sort the waste materials correctly. The respondents also noted that the current system is working efficiently. Addition of signage on the bins was suggested as an improvement.

Sheriff Hall, Halifax Campus

Aramark is the food provider at the Halifax Campus for all the residences. The chef at the Sheriff Hall was interviewed. Similar to Chartwells, Aramark also weighs the organic waste at the end of the shift at each station (Deli, Salads, etc.) by collecting it in plastic

containers with markings. Responses indicated that the kitchen staff are aware of the proper waste sorting methods. In contrast to the Agricultural Campus kitchen, most kitchen staff at the Sheriff Hall are part-time and international students. The chef also indicated that sometimes people would trip over the compost bins. Keeping the bins off the floor was suggested as an improvement. Two bins were located behind the kitchen for recyclables and aprons. Suggested improvements included colour-coding and signage for the bins. Two-three garbage cans were located in the kitchen.

5.3 Waste Audits

5.3.1 Audits before the changes

Table 4 shows the locations and dates for waste collection for the audits before the changes were applied. Waste was collected from McCain classrooms on the first floor, and McCain hallways 1st floor was collected on 22nd, 23rd, and 24th October, 2013. For the classrooms, waste was generated for all three days. For the McCain hallways, wastes in the paper and recyclable stream were available for 22nd November. Wastes for the organics and garbage streams had wastes for 22 and 23rd November. Wastes from a large Mona Campbell classroom were collected on 22nd, 23rd and 24th October, 2013. Breakdown of the contamination was not recorded for the 24th October. Therefore, the waste contamination was calculated using the wastes from 22nd and 23rd October. Wastes from Risley Hall, residence recycling room, 3rd floor were also collected on 22nd, 23rd and 24th October, 2013. Wastes from the garbage and paper streams were collected for all three days. Waste from the lunch room, Central Services Building, 2nd floor was collected on 26th, 27th and 28th October, 2013.

Table 4. Location and date of waste collection for pre audits

Location	**Stream Name**	**Waste data available for**
McCain Classrooms	Garbage	22nd, 23rd, 24th October
McCain Hallways	Paper	22nd October
	Recyclables	22nd October
	Organics	22nd, 23rd October
	Garbage	22nd, 23rd October
Mona Campbell classroom	Garbage	22nd, 23rd October
Risley Hall, Residence Recycling room, 3rd floor	Garbage	22nd, 23rd, 24th October
	Paper	22nd, 23rd, 24th October
Lunch Room, Central Services Building, 2nd floor	Garbage	29th, 30th, 31st October

McCain Classrooms

Waste from single-use garbage bins in six classrooms in the McCain building was collected on 22nd, 23rd and 24th October, 2013. Waste audits showed that amount of waste generated in each classroom varied with the day of the week. This could be due to the scheduling of evening classes on some days of the week. To balance this variation, waste from the same classroom was collected for three consecutive days. Figure 9 shows the contamination of the garbage stream from the classrooms. The total weight of the garbage stream from all classrooms was 5.72 kg. 45.5% of the contents of the garbage streams were contaminated with other streams. 69.3% of the contaminants belonged to the organics stream, 12.9% belonged in the recyclable stream, and 1.39% of the contaminated items belonged to the paper stream. Common organic contaminants were food waste such as banana peels and apple cores and coffee sleeves.

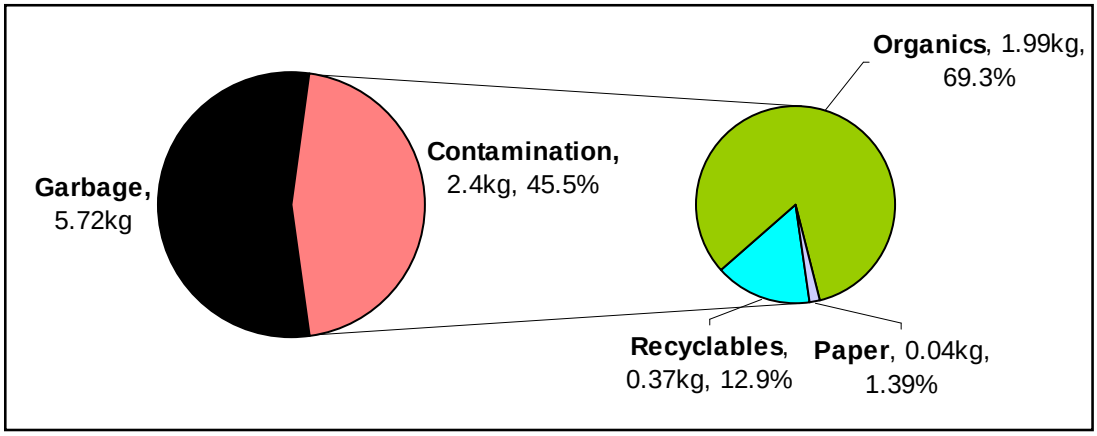

Figure 8: Contamination for the garbage stream in McCain classrooms

McCain Hallways

Paper, Recyclables, Organics and Garbage streams were collected from the McCain hallways. Contamination for each stream was calculated as % of the total weight. The total weight of the paper stream was .350 kg and showed no contamination (Appendix C). The total weight of the recyclable stream was .040 kg and showed no contamination (Appendix C). Figure 10 shows the contamination of the garbage stream in the McCain hallway. The contamination in the garbage stream was 16.4%. 55.6% of the contamination was organics while 44.4% contained recyclables. Organic contamination contained food napkins which were soaked in spilled coffee in the bag. The large hallway bins show low contamination, however the weights of the waste collected are also low.

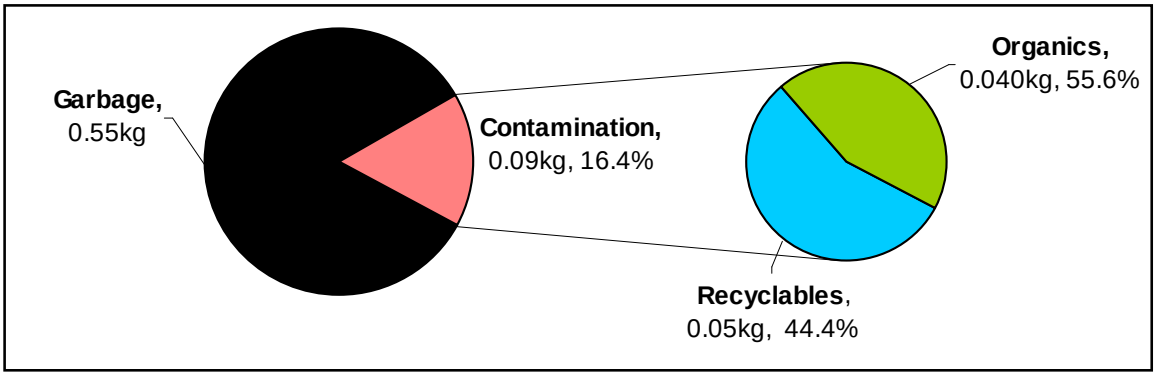

Figure 9: Contamination for the garbage stream from the McCain hallways

Mona Campbell Building

Figure 11 shows the contamination in the garbage stream in the classroom. The total weight of the waste collected from this location was 1.47kg. Contamination for this location was 63.9%. Organics constituted 69.1% of the contaminants found in the waste stream. 30.9% of the contaminants belonged to the recyclable stream. Another observation was that the waste bags had lots of liquid waste in them. No paper contamination was found in the waste stream from this location.

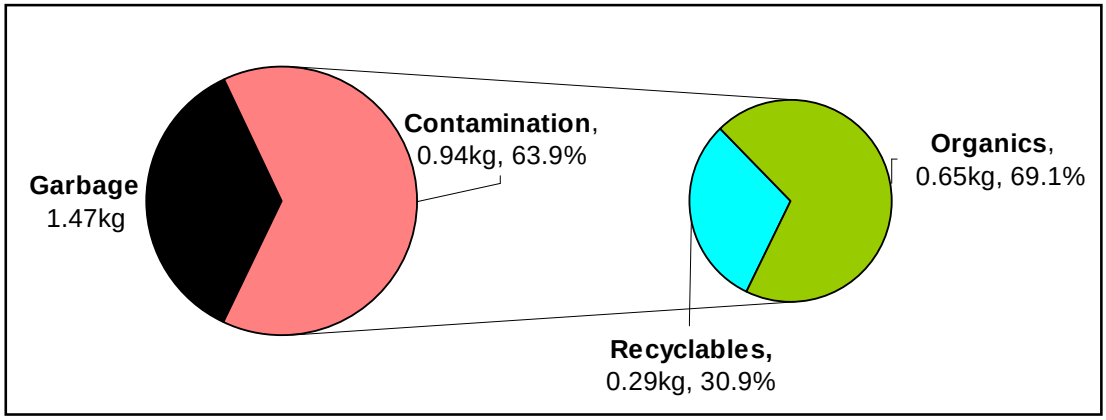

Figure 10: Contamination for single use garbage bin from classroom in Mona Campbell

Residence Recycling Room, 3rd Floor, Risley Hall

Waste from the Residence Recycling Room, 3rd Floor, Risley Hall was collected on 22nd, 23rd, and 24 October, 2013. Garbage and Paper streams were collected from this location. Figure 12 shows the contamination for both these streams. The garbage stream showed high contamination at 58.1%. Organics constituted 79.7% of the contamination while recyclables and paper constituted 15.1% and 5.2% of the contaminants respectively. Similar to the garbage stream, the paper showed the highest percentage of contaminants for the organics stream (89.8%). Particular to this stream was the presence of boxboard which constituted 80.7% of the organic contamination. Small amounts of garbage and recyclables were also found in the paper stream (8.2% and 2.0%) respectively.

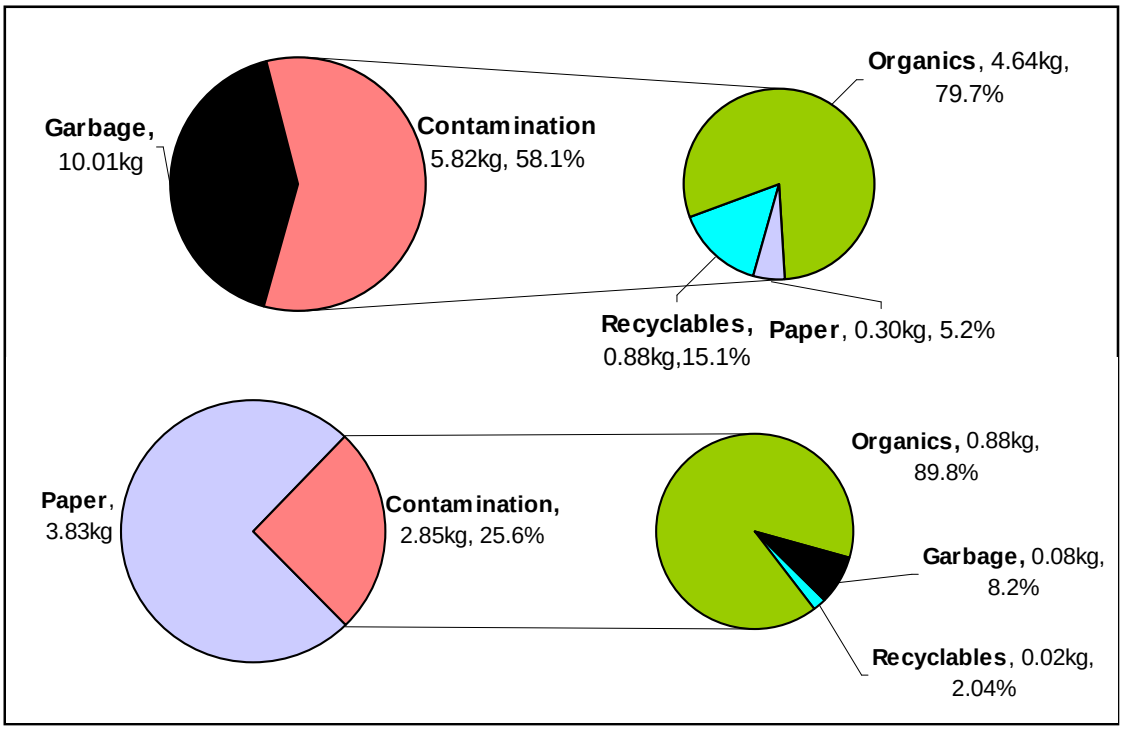

Figure 11: Contamination for garbage and paper streams from the Residence Recycling Rooms, 3rd Floor, Risley Hall

Lunch Room, Central Services Building

Waste from the lunch room in the Central Services Building was collected on 29th, 30th, and 31st October, 2013. Figure 13 shows the contamination for the single-use garbage bin at this location. Contamination for this waste stream was 83.0% with 78.2% of the contamination belonging to organics. 21.8% of contaminants belonged to the paper stream. This is not surprising as the waste bin was located in the lunch room where the amount of organics and recyclables generated is high.

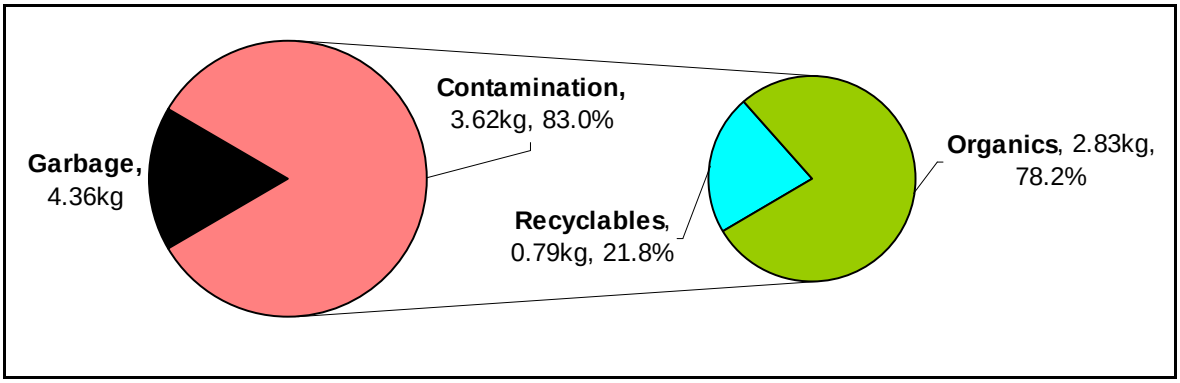

Figure 12: Contamination in single-use waste bin at the Lunch Room, Central Services Building

5.3.2 Audits after the changes

Once the changes were applied to the locations, users were given some time to get familiar with the system (1-2 days). Table 5 shows the locations and dates for waste collection after the changes were applied. Waste was collected from the waste bins on the 1st floor hallways in McCain building on 19th, 21st and 22nd November, 2013. Waste for recyclables was collected on 19th and 21st November, 2013. No waste for recyclables was generated on 22nd November. Paper, organics, and garbage streams showed waste for all three days. Waste was collected from the classroom in the Mona Campbell Building on 19th, 21st and 22nd November, 2013. No paper waste was generated on the 22nd November; hence no data was generated for this day. Data for the garbage stream was only available for the 19th as no waste was generated for this stream for 21st and 22nd November, 2013. Recyclables and Organics streams had waste for all three days. Waste from the residence recycling room on the 3rd floor in Risley Hall was collected on 19th, 20th and 21st November, 2013. The paper and garbage streams showed waste for all three days while recyclables from residence recycling rooms showed waste only for 20th November, 2013. Waste from the lunch room in the Central Services Building was collected on 26th, 27th and 28th November, 2013.

Table 5. Location and date of waste collection for post audits

Location	Stream Name	Waste data available for
McCain Building, 1st floor hallway	Paper	19th, 21st, 22nd November
	Recyclables	19th, 21st November
	Organics	19th, 21st, 22nd November
	Garbage	19th, 21st, 22nd November
Mona Campbell Classroom	Paper	19th, 21st November
	Recyclables	19th, 21st, 22nd November
	Organics	19th, 21st, 22nd November
	Garbage	19th November
Risley Hall, Residence Recycling room, 3rd floor	Garbage	19th, 20th, 21st November
	Paper	19th, 20th, 21st November
	Recyclables	20th November
Lunch Room, Central Services Building, 2nd floor	Garbage	26th, 27th, 28th November

McCain Hallways

Waste was collected from the waste bins on the 1st floor hallways in the McCain Buildings. As figure 14 shows the total weight of the paper waste was .600 kg. After the changes, the paper waste stream showed 23.3% contamination. 78.6% contamination was organics, mainly boxboard. Coffee cups and candy wrappers were common contaminants that contributed to the 21.4% of garbage contamination in the paper stream. The total weight of the recyclable waste stream was .490 kg (Figure 15). After the applied changes, the recyclable waste stream showed 28.6% contamination with garbage and organics. 85. 7% of contaminants belonged to the garbage stream while 14.3% of contamination was due to organic items. The organics waste did not show any contamination. The total weight of the organics waste was .770 kg. Figure 15 shows the total weight of the garbage was 1.19 kg. The garbage waste stream showed 27.8% contamination. Organic

contaminants constituted 87.9% of the contamination while recyclables and paper items constituted 9.1% and 3.0% respectively.

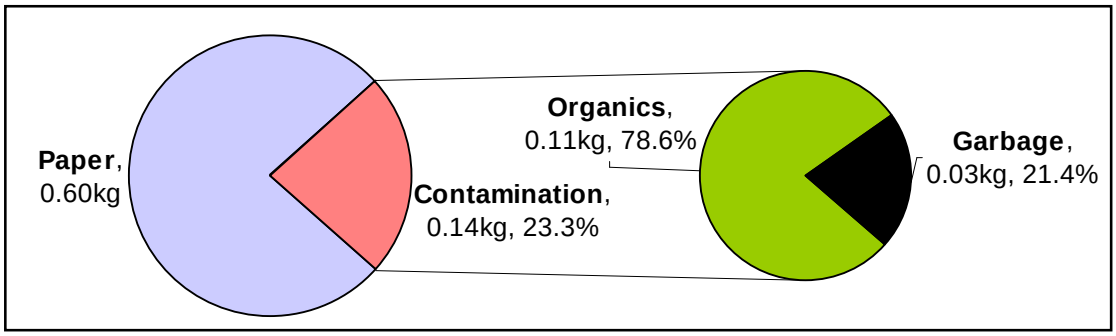

Figure 13: Contamination for the paper stream in McCain hallway after applied changes

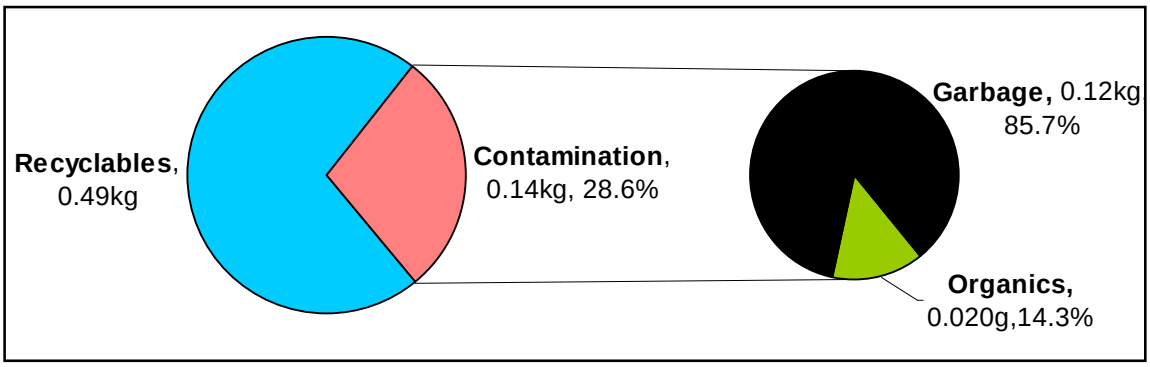

Figure 14: Contamination for the recyclables stream in McCain hallway after applied changes

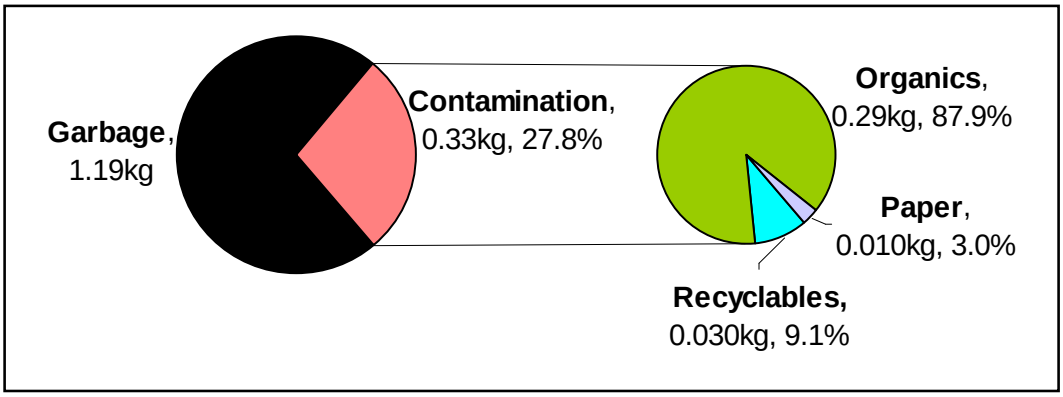

Figure 15: Contamination in the garbage waste stream in McCain hallways after applied changes

Mona Campbell Classroom

Wastes for the paper stream were collected on 19th and 21st November, 2013. The total weight of paper waste was .250 kg. The paper stream showed 8% contamination due to organic contaminants (paper plate). The total weight of the recyclable waste was .310 kg (Figure 17). 25.8% contamination was observed for the waste stream for recyclables. The contamination contained 75% garbage items (.060 kg) and 25% organic items (.020 kg). The total weight of the organics stream was .380 kg. This stream showed 7.9% contamination; 100% of the contamination was due to garbage items (.030 kgg). The total weight for the garbage stream was .250 kg. This stream showed 76% contamination due to the presence of organic contaminants (.190 kg).

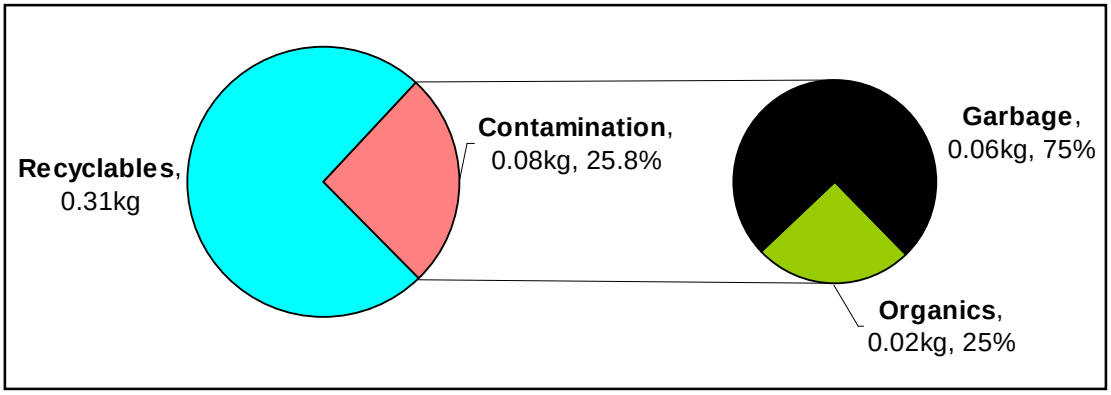

Figure 16: Contamination for recyclables from Mona Campbell classroom after the applied changes

Residence recycling room, 3rd floor, Risley Hall

Waste bags from the residence recycling room in Risley hall were collected on 19th, 20th and 21st November, 2013. Waste for the recyclables stream was collected only for the 20th November. The total weight of the recyclable waste was .390 kg and showed no contamination. The total weight of the paper stream was 8.440 kg and showed 21.8% contamination (Figure 18). 98.4% of the contamination was due to organic contaminants (mainly boxboard), 1.09% due to recyclables, and 0.54% due to garbage items. The total weight of the garbage stream was 9.880 kg (Figure 18). 43.3% contamination was observed for this stream. The contamination contained 59.1% organic items, 20.1% recyclables, 11.2% cardboard items, and 9.6% paper items.

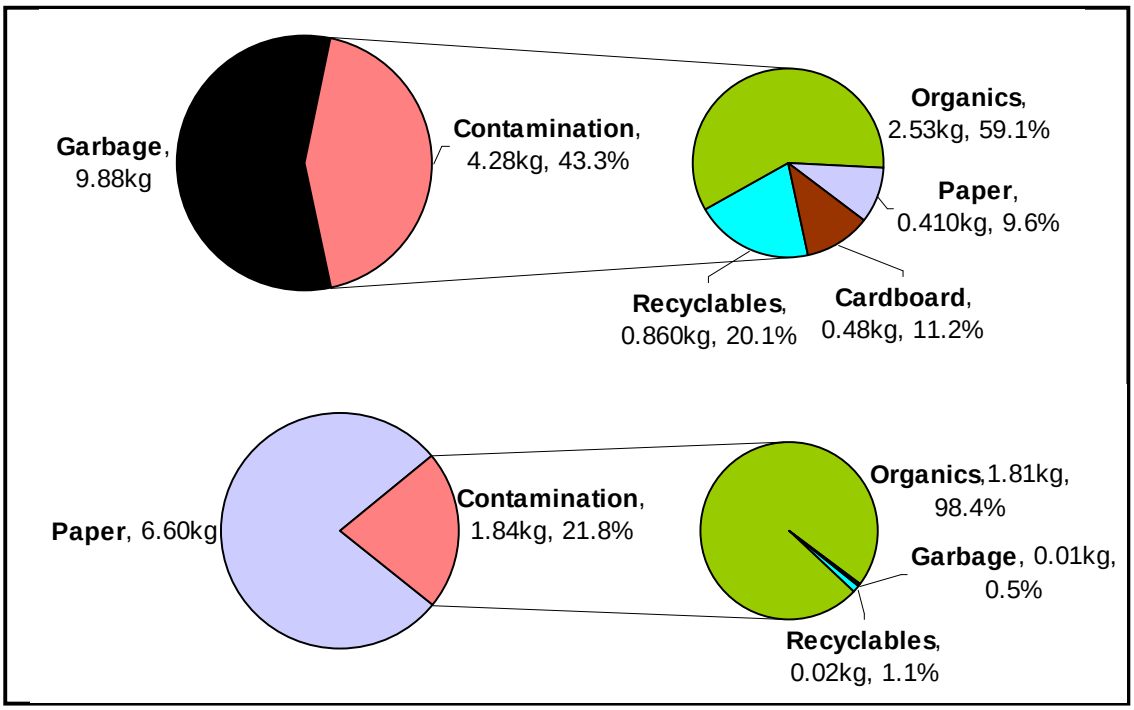

Figure 17: Contamination in the garbage and paper stream from Risley Hall after applied changes

Lunch Room, Central Services Building

Waste bags from the lunch room were collected on 26th, 27th and 28th November, 2013. The total weight of the garbage stream from the lunch room was 2.890 kg (Figure 19). The garbage stream showed 82.4% contamination which contained 83.6% organic items and 15.1% recyclables. Organic contaminants included boxboard, and food napkins.

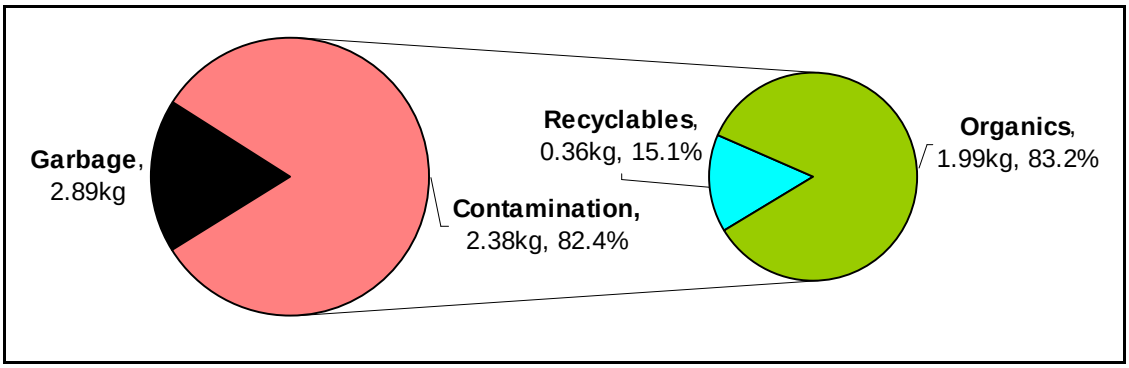

Figure 18: Contamination for the garbage stream from lunch room in Central Services Building after the applied changes

6.0 Discussion

Implementation of the system in the residences showed positive effects as the contamination in the garbage stream reduced from 58.1% to 43.3%. The residence recycling room showed the highest amount of waste collected for both pre and post waste audits (10.1kg and 9.88kg, respectively). This result is significant as large amount of waste were audited from this location. Therefore, for residences the implementation of the guidelines has shown a positive effect in the short-term. The paper stream did not show significant reduction in contamination. This could be due to the absence of boxboard on the signage in the form of pictures or written list of items on the signage.

Partial implementation of the design in the lunch room did not show any difference in the contamination in the garbage stream. As Binder (2012) points out, the response cost of accurate disposal is higher when people need to carry their waste past a garbage bin into the hallway. As it requires more effort from the user, it was not surprising that this implementation did not show any difference. Post-waste audits from the McCain and Mona Campbell buildings did not show positive results. However, these results are not indicative of the success of the system for these locations to improve source separation.

Low volumes of waste were collected during the study. Reasons for low waste could be low traffic in the hallways and classrooms for the days when waste was collected. The short-duration of three days for waste collection could be another reason for low volumes of waste. Waste collection for a longer time period may lead to higher waste volumes. Low wastes in the garbage stream from locations could also be a result of proper sorting of waste. However, comparison of waste weights from paper, organic and recyclables waste streams before and after do not show an increase in weight after the changes.

The results of the study align with previous studies which have investigated source-separation of waste. Similar to Duffy and Verges (2008), waste audits from residences show reduction in contamination when special openings were used. Addition of standardized signage and familiar colour coding helped reduce contamination as observed by Sustainability Victoria (2007) and Robinson et al. (2012). This study has laid the

groundwork for the implementation of these guidelines in other residences at Dalhousie University.

For many locations in Dalhousie, most guidelines are already in place. For example, most hallways have bins that have colour coded lids with different openings with descriptive signage with text. For such locations, installation of new bins will not be necessary. Since each new bin costs ~$90, adaptation of the current system to the recommended guidelines is a more practical solution. Going forward, the implementations of these guidelines in the new buildings will help Dalhousie achieve its goal of 75% diversion.

Since for most locations low volumes of waste were audited, a single item of contamination can skew the results dramatically. Since this study is a pilot study, data gathered during the study only generated short-term effects which will not be statistically significant for most locations due to the low volumes of waste generated. At the same time, lack of contamination in waste streams from these locations does not mean that the system is successful and will show consistent results for the future.
Therefore, long-term study with higher volumes of waste is expected to produce statistically significant results and trends in behavioural change of source separation.

7.0 Conclusions

Due to small volumes of waste that were collected during the study, it is difficult to comment on the success of the implementation of the guidelines. For the location in residence, highest volumes of waste were collected where the implementation of the changes showed significant reduction in contamination. Therefore, long-term study that audits higher volumes of waste over long period of time will not only produce statistically significant trends but also provide a true representation of the success of the changes for source-separation behaviour.

8.0 Limitations

Time constraints limited the scope of the study. Kitchenettes, dining rooms, and locations from Agricultural Campus were not included in the study. Designing standards for lab

spaces presented many challenges such as limited space and a combination of solid and hazardous wastes. Due to time constraints and the complexity of lab spaces, these issues were not fully explored within this study. Further studies for the waste bin standardization for labs are recommended. The waste bin guidelines created were based on the focus group results and literature. Then, new signs were designed by Dalhousie Communications and Marketing and external illustrator based on the suggestions of the focus group participants. Once the signs were created, the pre and post audits were conducted. Therefore, the time available for auditing was shortened given the need for the previous steps of focus groups and installation of the new signs. Low volumes of waste audited for the study generated skewed results. At this point, it is difficult to comment on the long term behavioural effect of this system under study and in view of the short-duration and low volumes of waste audited, the results are not significant enough to enable development of a long-term strategic policy on source separation.

9.0 Recommendations for future studies

A long-term study that builds on the work of this study is recommended. The long-term study will be able to generate statistically significant results and trends for behavioural change for the university population. Specifically, for the lunch room, studies comparing the baseline (black bin), partial implementation of the changes for this study (sign to take waste out with black bin present), and implementation of the changes completely (sign with removal of black bin) must also be conducted. Future studies should also consider collection of wastes from the new waste bin systems (put to compensate the flow of waste from classrooms) and already existing bins to assess the waste diversion from classrooms.

Studies must also compare the contamination rates of waste streams from locations where the design has not been implemented to the rates of waste streams where this implementation has taken place. For example, a study comparing the waste streams from the first and third floors (standard implemented) could be undertaken as part of the SUST 3502 *Campus as a Living Lab* course. Future studies should expand the scope of the current study to include more locations including the Agricultural Campus in Truro and other high traffic spots at the Halifax campuses such as the Student Union Building,

Auditoriums, and Lunchrooms. This study can also be followed by a social satisfaction survey to get feedback from the general university population about these changes and new bins.

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11.0 Appendices

Appendix A. Focus Group Research Questions

Research Study: Promoting Waste Diversion through Site Specific Waste Bin Standards
Conducted by: Naina Ummat, Office of Sustainability, Dalhousie University

Opening (5- 10 min)

Good (morning/afternoon/evening) everyone and thank you for joining us. My name is Naina Ummat and I am a Master's student at Dalhousie University at the School for Resource and Environmental Studies. I am completing a research study entitled: "Promoting Waste Diversion through Site Specific Waste Bin Standards." This study is supported by Resource Recovery Fund Board (RRFB) funding. Rochelle Owen, Director of the Office of Sustainability will be co-facilitating this focus group with me today. Previous waste audits at Dalhousie University have shown high rates of contamination in the garbage stream of (up to 60%) due to improper sorting. One suggested way to increase proper sorting is to provide solid waste bin standards for paper, recyclables, organics, and garbage streams that are specifically designed for a space by taking into consideration its physical layout, occupant behaviour, and type of waste generated. These designs must also address concerns of the Facilities Management with regards to procedures associated with waste collection and disposal. These space types are: Offices, Hallways, Meeting Rooms, Classrooms/Auditoriums, Laboratories, Residence recycling rooms, Front Dining Areas and Back Kitchen Areas in the residences. The outcome of this research is a standard waste bin system for all spaces listed. For example, a waste bin system designed for offices is designed to be implemented for all offices across campus. The objective of today's focus group is to identify the challenges and benefits of the proposed designs and to discuss design improvements. Your participation is integral to the project in pursuit of developing waste standards for space types at Dalhousie University. The focus group should last about two to two and a half hours. During this focus group I will record our conversation. If discussion about some topics is uncomfortable, we'll just move on. The only people who will hear and see the focus

group results will be members of the research team. You are requested to keep all information from the focus group confidential and to refrain from discussion of any details outside of the focus group. This includes information about who else was participating in the focus group. All original notes, digital recordings and back-up files will be stored at Dalhousie University in a secure location in the School of Resource and Environmental Management and will be kept until the end of December 2013.

Let's start by introducing ourselves.

Question 1

What are some barriers to proper material sorting (paper, recyclables, organics, waste) at Dalhousie? (Prompts: confusing signage, bins too far, over binning with black bins)

Question 2

Are there some material streams that have more waste contamination than others (Prompts: coffee cups in the wrong bin)? If so, which material streams show more contamination?

Question 3

What improvements can be made at Dalhousie University to increase sorting? (Prompts: better signage, convenient locations, signs with pictures and words)

Question 4

This study is also investigating design waste bins for laboratories to facilitate solid waste sorting in labs. What safety concerns do you have with sorting of lab waste? (Prompts: not clean enough, hazardous materials ending up in the recyclable stream)

Question 5

What are the benefits and problems of these designs? (Prompts: uses too many bags, bag size not easy to handle, takes too much time).

Question 6

What modifications to the proposed designs would you suggest so that it promotes increased diversion, considers custodial time and material costs (i.e. bags) (Prompts: change the location of the bin, change the size of the bin, change the sign content).

Appendix B. Interview Script and Questions

Research Study: Promoting Waste Diversion through Site Specific Waste Bin Standards
Conducted by: Naina Ummat, Office of Sustainability, Dalhousie University

Good (morning/afternoon/evening). Thank you for agreeing to participate in this study today. My name is Naina Ummat, and I am a graduate student in the School for Resource & Environmental Studies at Dalhousie University. I am working with the Office of Sustainability to explore issues surrounding waste bin designs at Dalhousie.
Previous waste audits at Dalhousie University have shown high rates of contamination (up to 60%) due to improper sorting. The research entitled "Promoting Waste Diversion through Site Specific Waste Bin Standards" hypothesizes that implementation of standard solid waste designs for specific space types will increase waste sorting at the University. The project focuses on solid waste streams of paper, recyclables, organics, and garbage. Specific space types for the project include kitchens/laboratories.
Before I start recording the interview, I want to tell you a little bit about how our conversation will go. Our conversation will be about your daily practices with waste and your suggestions regarding the new designs for your space. The interview should take about 30-45 minutes.

Question 1
What do you think of current waste management in labs/kitchens?

Question 2
Do you face any challenges while sorting your waste? If so, what are they?

Question 3
Do you think the kitchen/ lab has more bins than necessary?

Question 4

Has the physical space of the area ever created challenges for convenient bins for sorting? If so, in what way?

Question 5

What improvements would you suggest to the current bin systems to improve waste diversion?

Question 6

Is there anything else that you would like to add before we end the interview?

Thank you for your participation. All information from the interview will be analyzed in the next month. Information you shared today will remain confidential. If you have any questions or concerns regarding today's interview or the research in general please do not hesitate to contact me at naina.ummat@dal.ca or Dr. Fiona Black, Associate Dean (Research), Dalhousie University at fiona.black@dal.ca / 902-494-1901. I will be in touch with a copy of the preliminary analysis or direct quotations for your review and comment. Thank you so much, it was great to talk to you!

Appendix C: Waste Audit Results

McCain Hallway – Pre-audit

Paper	
date	22-Oct
Sample:	1
Paper (g)	350
Contamination (g)	0
Contamination (g)	
Recyclables	0
Organics	0
Garbage	0
Other	0

Recyclables	
Date	22-Oct
Sample:	1
Recyclables (g)	40
Contamination (g)	0
Contamination (g)	
Paper and cardboard	0
Organics	0
Garbage	0
Other	0

Organics			
date	22-Oct	23-Oct	**TOTAL**
Sample:	1	2	
Organics (g)	220	170	390
Contamination (g)	0	0	0
Contamination (g)			
Paper and cardboard	0	0	0
Recyclables	0	0	0
Garbage	0	0	0
Other	0	0	0

Garbage			
Date	22-Oct	23-Oct	**TOTAL**
Sample:	1	2	
Garbage (g)	290	260	550
Contamination (g)	0	90	90
			460
Contamination (g)			
Recyclables	0	50	50
Organics	0	40	40
Paper	0	0	0
Cardboard	0	0	0
Other	0	0	0

Location: McCain Hallway – Post-audit

Paper					
Date	19-Nov	21-Nov	22-Nov	22-Nov	**TOTAL**
Sample:	1	2	3	4	
Paper (g)	70	70	370	90	600
Contamination (g)	10	0	40	90	140
					460
Contamination (g)					
Recyclables	0	0	0	0	0
Organics	0	0	20	90	110
Garbage	10	0	20	0	30
Other	0	0	0	0	0

Recyclables			
Date	19-Nov	21-Nov	**TOTAL**
Sample:	1	2	
Recyclables (g)	270	220	490
Contamination (g)	50	90	140
			350
Contamination (g)			
Paper and cardboard	0	0	0
Organics	10	10	20
Plastics (#3,5,6,7)	0	0	0
Garbage	40	80	120
Other	0	0	0

Organics					
Date	19-Nov	21-Nov	21-Nov	22-Nov	**TOTAL**
Sample:	1	2	3	4	
Organics (g)	90	170	190	320	770
Contamination (g)	0	0	0	0	0
Contamination (g)					
Paper and cardboard	0	0	0	0	0
Recyclables	0	0	0	0	0
Garbage	0	0	0	0	0
Other	0	0	0	0	0

Garbage						
Date	19-Nov	21-Nov	21-Nov	22-Nov	22-Nov	**TOTAL**
Sample:	1	2	3	4	5	
Garbage (g)	100	380	480	130	100	1190
Contamination (g)	70	150	40	50	20	330
						860
Contamination (g)						
Recyclables	0	0	20	10	0	30
Organics	70	150	20	40	10	290
Paper	0	0	0	0	10	10
Cardboard	0	0	0	0	0	0
Other	0	0	0	0	0	0

McCain Classrooms – pre-audit

Garbage									
date	22-Oct	23-Oct	24-Oct	22-Oct	23-Oct	24-Oct	22-Oct	23-Oct	24-Oct
Location	McCain 1184	McCain 1184	McCain 1184	McCain 1170	McCain 1170	McCain 1170	McCain 1198	McCain 1198	McCain 1198
Sample:	1	2	3	4	5	6	7	8	9
Garbage (g)	180	40	60	460	480	190	650	180	800
Contamination (g)	120	10	30	40	90	150	420	110	310
Contamination (g)									
Recyclables	10	0	30	20	20	40	70	50	0
Organics	110	0	0	20	70	110	350	30	310
Paper	0	10	0	0	0	0	0	30	0
Cardboard	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0

Garbage									
date	22-Oct	23-Oct	24-Oct	22-Oct	23-Oct	24-Oct	23-Oct	24-Oct	**TOTAL**
Location	McCain 1116	McCain 1116	McCain 1116	McCain 1102	McCain 1102	McCain 1102	McCain 1130	McCain 1130	
Sample:	10	11	12	13	14	15	17	18	
Garbage (g)	470	70	350	220	240	140	30	710	5270
Contamination (g)	260	0	200	170	170	50	10	260	2400
									2870
Contamination (g)									
Recyclables	50	0	0	0	0	30	0	50	370
Organics	210	0	200	170	170	20	10	210	1990
Paper	0	0	0	0	0	0	0	0	40
Cardboard	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0

Location: Mona Campbell Classroom – pre-audit

Garbage			
Date	22-Oct	23-Oct	**TOTAL**
Sample:	1	2	
Garbage (g)	280	1190	1470
Contamination (g)	150	790	940
			530

Contamination (g)			
Recyclables	100	190	290
Organics	50	600	650
Paper	0	0	0
Cardboard	0	0	0
Other	0	0	0

Location: Mona Campbell Classroom – post-audit

Paper			
Date	19-Nov	21-Nov	**TOTAL**
Sample:	1	2	
paper (g)	50	200	250
Contamination (g)	20	0	20
			230

Contamination (g)			
Recyclables	0	0	0
Organics	20	0	20
Garbage	0	0	0
Other	0	0	0
Other	0	0	0

Recyclables				
Date	19-Nov	21-Nov	22-Nov	**TOTAL**
Sample:	1	2	3	
recyclables (g)	50	70	190	310
Contamination (g)	0	30	50	80
				230

Contamination (g)				
paper and cardboard	0	0	0	0
Organics	0	20	0	20
Plastics	0	0	0	0
Garbage (g)	0	10	50	60
Other	0	0	0	0

Organics

Date	19-Nov	21-Nov	22-Nov	**TOTAL**
Sample:	1	2	3	
organics (g)	40	150	190	380
Contamination (g)	0	10	20	30
				350

Contamination (g)

paper and cardboard	0	0	0	0
Recyclables	0	0	0	0
Garbage	0	10	20	30
Other	0	0	0	0
Other	0	0	0	0

Garbage

Date	19-Nov	**TOTAL**
Sample:	1	
Garbage (g)	250	250
Contamination (g)	190	190
		60

Contamination (g)

Recyclables	0	0
Organics	190	190
Paper	0	0
Cardboard	0	0
Other	0	0

Location: Residence Recycling Room, 3rd floor, Risley Hall – pre-audit

Garbage													
Date	22-Oct	22-Oct	23-Oct	23-Oct	23-Oct	23-Oct	23-Oct	23-Oct	24-Oct	24-Oct	24-Oct	24-Oct	**TOTAL**
Sample:	1	2	3	4	5	6	7	8	9	10	11	12	
Garbage (g)	410	720	1490	690	1080	740	920	1200	690	170	460	1440	10010
Contamination (g)	150	370	690	450	860	580	730	980	280	250	200	280	5820
													4190
Contamination (g)													
Recyclables	0	0	10	10	240	0	130	100	40	200	50	100	880
Organics	150	200	670	440	570	580	600	880	240	30	150	130	4640
Paper	0	170	10	0	50	0	0	0	0	20	0	50	300
Cardboard	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0

Location: Residence Recycling Room, 3rd floor, Risley Hall – post-audit

Garbage											
Date	19-Nov	19-Nov	19-Nov	19-Nov	19-Nov	19-Nov	20-Nov	20-Nov	21-Nov	21-Nov	**TOTAL**
Sample:	1	2	3	4	5	6	7	8	9	10	
Garbage (g)	680	1560	760	870	500	410	3170	680	460	790	9880
Contamination (g)	520	760	370	420	390	270	850	290	270	140	4280
											5600
Contamination (g)											
Recyclables	0	200	180	110	120	100	0	30	0	120	860
Organics	370	230	0	110	270	170	850	260	270	0	2530
Paper	0	0	190	200	0	0	0	0	0	20	410
Cardboard	150	330	0	0	0	0	0	0	0	0	480
Other	0	0	0	0	0	0	0	0	0	0	0

Location: Residence Recycling Room, 3rd floor, Risley Hall – pre-audit

Paper				
Date	22-Oct	23-Oct	24-Oct	**TOTAL**
Sample:	1	2	3	
paper (g)	960	490	2380	3830
Contamination (g)	490	240	250	980
				2850
Contamination (g)				
Recyclables	20	0	0	20
Organics	470*	240*	170	880
Garbage	0		80	80
Other	0	0	0	
Notes:	* boxboard	* boxboard		

Location: Residence Recycling Room, 3rd floor, Risley Hall – pre-audit

Paper							
Date	19-Nov	19-Nov	20-Nov	20-Nov	20-Nov	21-Nov	**TOTAL**
Sample:	1	2	3	4	5	6	
paper (g)	890	1080	680	1750	3430	610	8440
Contamination (g)	300	280	350	0	720	190	1840
							6600
Contamination (g)							
Recyclables	20	0	0	0	0	0	20
Organics	280	280	340	0	720	190	1810
Garbage	0	0	10	0	0	0	10
Other	0	0	0	0	0	0	0

Location: Lunch Room, Central Services Building, 2nd floor – pre-audit

Garbage				
date	29-Oct	30-Oct	31-Oct	**TOTAL**
Sample:	1	2	3	
Garbage (g)	2580	1090	690	4360
Contamination (g)	2140	990	490	3620
				740
Contamination (g)				
Recyclables	430	310	50	790
Organics	1710	680	440	2830
Paper	0	0	0	0
Cardboard	0	0	0	0
Other	0	0	0	0

Location: Lunch Room, Central Services Building, 2nd floor – post-audit

Garbage				
date	26-Nov	27-Nov	28-Nov	**TOTAL**
Sample:	1	2	3	
Garbage (g)	910	900	1080	2890
Contamination (g)	720	750	910	2380
				510
Contamination (g)				
Recyclables	120	70	170	360
Organics	570	680	740	1990
Paper	0	0	0	0
Cardboard	0	0	0	0
Other	0	0	0	0

Appendix D. Waste Bin Standards for Dalhousie University

Purpose

This document provides solid non-hazardous waste bin standards for spaces at Dalhousie University. These standards are developed to help Dalhousie achieve its goal of 75% diversion rate. The implementation of these standards will also remove unnecessary single black bins present on campus. Considerations for all spaces are followed by standards for each waste bin space type. The considerations provide the guidance for unique spaces that require some modification from standard for each waste bin space type.

Overall Considerations

1. Signage: Each bin should be associated with three types of signage
    a. Each bin must have the stream name near the opening of the bin (Figure 1). These stickers are provided by HRM and Colchester waste educators.
    b. A descriptive text label listing the acceptable items in each bin type must be placed on the front of the bin (Figure 19). These stickers are provided by HRM and Colchester waste educators.
    c. Bins in each space must have pictures of acceptable waste materials. These can be placed in the space above the bin, providing the user visual information about sorting waste materials. These posters fit with in bins that have flip up signs, or are fastened to the wall with industrial Velcro. (Figure 1). These signs are available from the Dalhousie custodial supervisors.

2. Colour Coding
    a. Signage is colour coded so that they provide a visual clue for the material: Paper (Gray); Recyclables (Blue); Organics (Green); Waste (Black); Refundables (Blue but different from Recyclables).
    b. When possible, bins in each space should have coloured tops. The following are recommended:
    Paper –Gray
    Recyclables – Blue
    Organics – Green
    Garbage – Black

3. Openings and Order
    a. When possible, each bin should have specific openings for different waste streams. The following are recommended (Figure 19):
    Paper – Slit openings
    Recyclables – Round opening
    Organics – Round/square openings
    Garbage – Flap/square openings

b. Each four bin series should be always in the order of PROG with the labels in the right order and have the same type. P (Paper); R (Recyclables); O (Organics); G (Garbage) (Figure 19).

Figure 19: Design guidelines to be implemented across Dalhousie campuses

1. Offices

1. Remove all single black garbage cans.
2. Replace with recyclable bin with a small side saddle bin for black garbage (Figure 20).
3. The user is responsible for emptying the blue and black containers into the four-bin sorting station in the hallway.
4. The user must bring the food waste/ green garbage outside to the four-bin sorting station in the hallway daily or bring in lunch container home for composting.
5. When the blue box system is implemented, clear communication regarding the role of the office resident and the custodial staff should take place. During this time it must be clearly communicated that the custodial staff is not responsible for emptying out the blue box or side saddle bins from offices.

Figure 20: Bin design standard for Offices

2. Hallways

1. All hallways must have at least one bin for Paper, Recyclables, Organics and Garbage (PROG) (Figure 21).
2. Unless collection of refundables is set up by the students and the subsequent revenue is used towards student society/activities, refundables and recyclables should be collected together in the recyclable bins as all refundables are recyclable.
3. These bins must be placed in PROG or PROG+R order.
4. The most appropriate sized container should be used for hallways. Facilities management staff can choose the size of the container that is most appropriate for hallways. These bins are available in 16, 20, 23, and 32 gallon capacities.
5. For areas that have high traffic, the best option should be implemented. If the current bins cannot be repurposed, then these should be replaced with the new bins which have all the recommended features.

Figure 21: Bin design standard for hallways

3. Student Lounges/Kitchenettes

1. No more than one black bin, and at least one organics bin and must be provided within this space (Figure 22).
2. For space constrained locations, compost bins must be provided within the space.
3. Recyclables and paper recycling bins for such spaces can be moved out to the hallway, if the four bin system is not already in place. If such a system is in place, then recyclable and paper recycling bins for this particular location are not necessary.
4. The custodial staff can choose the most appropriate sized container for this space type. Bins are available in small (7 and 10 gallons) and larger hallway sizes at (16, 20, 23, and 32 gallon) capacities.

Figure 22: An example of bin design standard for larger lunchrooms/kitchenettes

4. Meeting Rooms

1. For locations that have *high usage or catering*, bins for Paper, Recycling, Organics and Garbage must be provided. They must be placed in PROG order (Figure 23). The size of the bins can be smaller than hallway bins depending on the size of the room. Smaller bins are available in 7 and 10 gallon capacities. Remove all single black bins from meeting rooms.
2. For locations that are not frequently catered, *signs directing users to the nearest four-bin sorting station must be provided* (Figure 24). Signs are provided by custodial supervisors. Black bins are removed from the room. Four-bin sorting station in the hallway must be located nearby to the meeting room.
3. The custodial staff can choose the size of the container that is most appropriate for meeting rooms. Bins are available in small (7 and 10 gallons) and larger hallway sizes at (16, 20, 23, and 32 gallon) capacities.

Figure 23: Bin standards for meeting rooms frequently used or with catering

Figure 24: Sign to take waste out in the hallway

5. Classrooms

1. For classrooms with large seating capacity, bins for paper, recyclables, organics, and garbage must be provided in the classroom. All single black bins from classrooms must be removed (Figure 25).
2. For space constrained locations garbage and paper bins can be moved outside the classroom.
3. Classrooms with smaller seating capacity must have a sign directing users to the nearest four-bin sorting station must be provided. Black bins are removed from the room (Figure 26).
4. Depending on the waste generation volume and trends the custodial staff may wish to place the four bin system inside a smaller classroom.
5. The custodial staff can choose the size of the container that is most appropriate for classrooms. Bins are available in small (7 and 10 gallons) and larger hallway sizes at (16, 20, 23, and 32 gallon) capacities.

Figure 25: Bin standards for classrooms

Figure 26: Sign to take waste out in the hallway

6. Auditoriums

1. All single black garbage bins must be removed.
2. Bins for Paper, Recyclables, Organics and Garbage must be provided (Figure 27).
3. These bins can be placed together (in PROG order) or separately depending on the space of the location. If placed separately, single black bins should be avoided.
4. The custodial staff can choose the size of the container that is most appropriate for auditoriums. The waste bins are available in 16, 20, 23 and 32 gallon capacities.

Figure 27: An example of bin design standard for auditoriums

7. Residences

1. All single black garbage bins must be removed.
2. Bins for Paper, Recyclables Organics and Garbage must be provided. If an organics bin is provided in a publically available space on the floor as opposed to a room due to space, a sign directing the user to this location must be provided.
3. Additional bins for refundables and broken glass, cardboard may be provided (Figure 28).
4. These bins must have a description of acceptable materials with pictures.
5. The custodial staff can choose the size of the container that is most appropriate for residences.
6. Dormitories in residences must be provided with the office design to provide convenient waste sorting in dormitories.

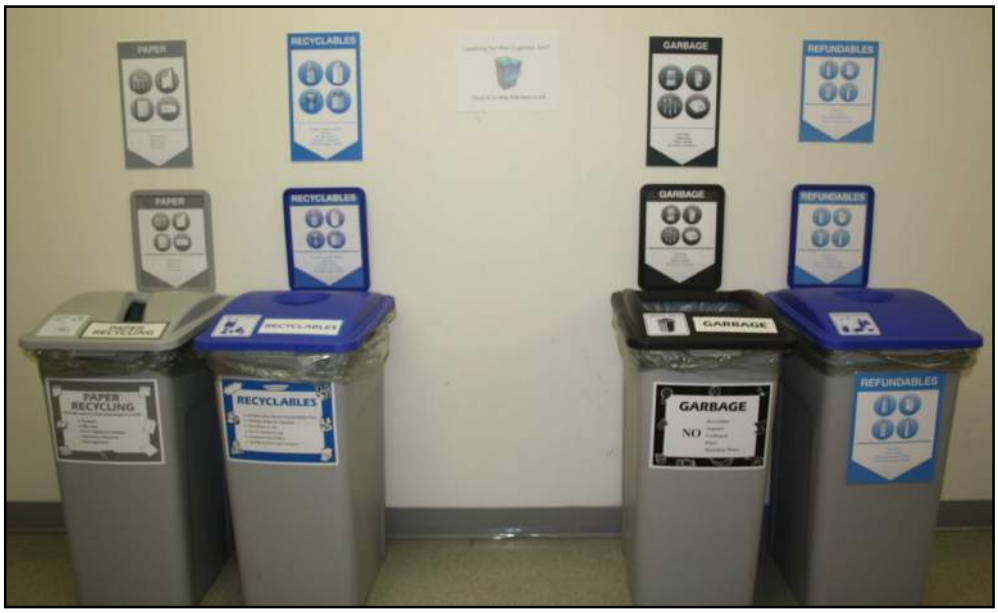

Figure 28: Bin design standard for residences with a sign directing users to the location of the organics bin

8. Kitchens

1. Single black bins must be removed or minimized.
2. In space constrained locations, it is recommended that organics bin be placed near the food preparation areas.
3. All organic carts must have text descriptions of acceptable materials accompanied with pictures.
4. If the bins are moved around, the pictures of waste materials must be placed on the bins.
5. Bins should be colour coded.

9. Dining Rooms

1. All single black bins must be removed.
2. Bins for Recyclables, Organics and Garbage must be placed in the dining room (Figure 29).
3. It is recommended that the bins be placed near the location where students deposit their plates and utensils.
4. If space is a constraint a large organic bin should be provided with a smaller garbage can with signs as most of the material in dining halls such as napkins is compostable.

Figure 29: Bin design standards for dining rooms