

AN INVESTIGATION INTO CIGARETTE BUTT RECYCLING AT UBC

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APSC 262 FINAL REPORT

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ABSTRACT

In an effort to achieve a zero-waste campus, UBC is looking at ways of improving its cigarette disposal methods to reduce the impact on the environment as well as reduce the amount of litter sent to the landfill. This investigation was conducted through the use of scholarly articles, annual reports, and interviews. This investigation seeks to compare possible solutions and recommend the best option for UBC to implement. The aforementioned objectives of this report were achieved by comparing two of three proposed solutions: recycling with TerraCycle, and continuing to send the waste to the landfill. The third option, in-house recycling, was removed from contention following a meeting with Bud Fraser due to its high capital costs. In order to reach the most viable solution, a triple bottom line assessment was conducted to compare the social, economic, and environmental merits of each solution. Through the analysis it was concluded that recycling with TerraCycle will have the least environmental impact and the most positive social impact. Improving the collection method would be necessary, which would come at an additional financial cost. However, due to the positive environmental and social impact this solution would have, it best conforms to the goals that UBC has demonstrated that it is striving for.

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GLOSSARY

- Cellulose Acetate.....A synthetic fibre made of a certain type of plastic
Delustrant.....A substance that reduces the lustre of synthetic fibres
Plasticiser.....An additive that increases the fluidity of a material
The Client.....For the purposes of this report, “The Client” refers to Bud Fraser

1.0. Project Introduction

The University of British Columbia has been moving towards becoming a zero-waste campus by moving away from landfill destined goods towards recyclable and compostable goods. Working towards the zero-waste campus, UBC is looking into improving its cigarette butt disposal programs. Currently all of the cigarette butts collected at UBC are sent to the Vancouver landfill where they are disposed of without removing any toxic substances in the cigarette butts.

This investigation is focused primarily on different disposal methods that UBC can use to process the cigarette butts. Although the processing of cigarette litter has two stages, collection and disposal, at the request of the client, Bud Fraser, this report does not thoroughly discuss collection methods but rather focuses on the disposal methods available after the butts have been collected. However, regardless of the solution UBC chooses to implement, administration needs to implement a more effective plan for collecting cigarette butts on campus. Hence, collection has been included as a constant factor in the analysis of all options explored.

To reach a viable option for UBC, three different solutions were proposed and were compared through a triple bottom line analysis. Some of the factors analyzed include the following:

- health effects to waste management crew
- economic incentives
- cost of implementation; and
- overall environmental impact

The research for this investigation was based primarily from academic articles, city reports, and communication with TerraCycle representatives (please find the transcript from an interview with Daniel Caunter, a TerraCycle representative, in Appendix B).

This report will first introduce the potential solutions that were brainstormed. Following this, it will cover the triple bottom line analysis comparing the potential solutions socially, economically, and environmentally. It will then discuss the conclusions and recommendations being made for this investigation, which will be followed by the bibliography and applicable appendixes for additional information.

This report uses an APA citation style and follows the outline set by the Final Report document provided by this course on the UBC Connect website.

2.0. POTENTIAL SOLUTIONS

Throughout the investigation, three potential solutions were brainstormed. They are:

1. The first option is to treat cigarette butts as non-recyclable garbage and dispose of them in landfills. This is the method currently in place at UBC.
2. The second option is to ship the cigarette butts to a recycling facility in the Lower Mainland. Currently there is only one cigarette butt recycling program available in the Lower Mainland called TerraCycle. TerraCycle is the only organization that has a collection program in place and a recycling facility that is able to process the cigarette butts and transform them into useful materials such as shipping pallets (Brown, 2015). TerraCycle allows individual shipments to its facilities and any residential or commercial building can sign up for TerraCycle's cigarette butt program. TerraCycle requires individuals to collect the cigarette butts themselves, but it provides free shipment to their facilities. Every pound of cigarette earns the collector \$1 in credits, which will be donated to their charity of choice.
3. The third option is to build a recycling facility on campus solely for treating cigarette waste. This facility would transform cigarette butts into useful products that could be used on and off campus, creating revenue for the university.

After speaking to our client, since the capital cost of the third option is too high, it is not a feasible option for UBC at this point in time (Fraser, 2015). Furthermore, the technology is still not fully available to easily replicate processes implemented by companies such as TerraCycle or in University laboratories. Hence, we will not analyze this option as a viable solution any further in this report. Our triple bottom line analysis will therefore compare the advantages and disadvantages of recycling and disposing of cigarette butt litter on campus.

It should be noted that even though implementing a more effective program for collecting cigarette butt litter on the Vancouver campus is not our main focus, it is essential to the success of any solution that UBC chooses to follow.

3.0. TRIPLE BOTTOM LINE ANALYSIS

To perform a triple bottom line analysis, we divided the three aspects up into a social analysis, an economic analysis, and an environmental analysis. Conclusions are determined for each analysis after comparing the merits of both options. Following each individual analysis, an overall conclusion will be discussed in section 4.0.

3.1. SOCIAL ANALYSIS

The major social considerations when it comes to cigarettes arise from the health risks present from second-hand smoke and from coming in contact with the waste while handling it during collection and processing. For the purposes of this analysis, extrapolation from data regarding cigarette litter had to be done since little research has been conducted on the specific social factors regarding cigarette disposal.

Regardless of the disposal method that is chosen UBC will have to do a better job of collecting and processing cigarette litter. The full analysis of the collection methods has been neglected in this report as we focused mainly on the disposal mechanisms as requested by the client. However, many of the social factors relate to the collection of the litter, thus a brief analysis on this social consideration is conducted in the following paragraphs.

The major social consideration regarding cigarette disposal pertains to the health of bystanders, as well as those involved in the collection and processing of the litter. In a letter from Vancouver Coastal Health (VCH) to the city of Richmond, VCH raised the concern that having cigarette receptacles installed will create unofficial smoking areas and the area around it will have higher concentrations of second-hand smoke. Their concern is further emphasized as they point out that in densely populated areas, these cigarette receptacles are often placed in proximity to building entrances, windows, air intakes and bus stops (Bycraft, 2014).

However, our observation of different buildings on campus has shown that regardless of whether or not a cigarette receptacle is placed near a building, many smokers concentrate in proximity to building entrances and covered areas, especially on rainy days. In order to do a better job of collecting the litter while reducing the health risks of bystanders it is recommended that:

- There should be better enforcement of current UBC smoking policies around buildings
- Receptacles should not be placed within proximity of building entrances and air intakes; and
- Many receptacles should be placed around campus so that the smokers are distributed more evenly to reduce the concentrations of second-hand smoke at a single receptacle.

The following sections outline the advantages and disadvantages of recycling and disposing of cigarette waste in regards to a social aspect.

3.1.1. SOCIAL ANALYSIS: NOT RECYCLING – COLLECTION + LANDFILL

Studies have shown that the heavy metals such as lead, cadmium and chromium all leach from cigarette butts when in an aqueous solution. While the concentration of leachates from a single cigarette butt is small, when looking at the scale of litter produced on campus the toxicity of these leachates pose a serious health concern (Moerman & Potts, 2011). Cigarette litter sent to the landfill is unprocessed and will still have all of the contaminants and heavy metals present. This poses a serious health risk to the landfill crews that process the waste as they can come in contact with the cigarette waste and its contaminants and heavy metal leachates.

3.1.2. SOCIAL ANALYSIS: RECYCLING – COLLECTION + TERRACYCLE

The health risks discussed above also apply to sending the cigarette butts to TerraCycle, however, once the cigarette butts arrive at the TerraCycle facility they are correctly sanitized and the heavy metals are safely removed to minimize the health risks posed to the recycling crew. In contrast to sending the butts to the landfill, there are several positive social benefits of recycling. Firstly, instilling the habit of properly disposing of and recycling cigarette butts may cause smokers to change their disposal methods not only when they smoke on campus but anywhere they smoke. Secondly, TerraCycle donates money to a charity of UBC's choice for every pound of litter received, this will allow UBC to have further positive benefits on the community without any additional expenses or effort. Lastly, a partnership with TerraCycle to recycle the cigarette waste on campus will serve as a model for other universities to follow, which will further reduce the impact of cigarette butts throughout university campuses in Canada and elsewhere.

3.1.3. SOCIAL ANALYSIS CONCLUSIONS

From the social analysis provided in the above sections it is clear that there are several health risks involved with the collection and processing of cigarette butts. In fact, the health risks posed to the UBC community are nearly the same for both options. However, these risks can be minimized by following adequate procedures and using protective gear at all times during the collection and processing of cigarette waste. The point that differentiates both options are the positive social benefits that arise from recycling the cigarette litter including the reduced health risk to landfill employees as well as the charitable donations made by TerraCycle on behalf of UBC. By choosing to recycle cigarette waste with TerraCycle, UBC will have a positive impact on the community and will help change the disposal habits of smokers to properly dispose of their cigarette butts wherever they go.

3.2. ECONOMIC ANALYSIS

There are many different potential costs associated with the collection and disposal or recycling of cigarette waste. The following sections contain a brief analysis constructed by extrapolating from similar situations found throughout our research.

3.2.1. ECONOMIC ANALYSIS: NOT RECYCLING – COLLECTION + LANDFILL

According to the UBC Sustainability Annual Report in 2013 over 10,000 tons of garbage was collected at UBC and only 66.7% of that was diverted for recycling (UBC Sustainability Annual Report 2013: Vancouver Campus, 2013). Based on our research 11 of the 10,000 tons are cigarette butts (please see Appendix A for a more in-depth explanation of this value and Appendixes C, D, E, and F for more facts some posters and brochures from TerraCycle about cigarettes). Using available information regarding the Canadian population of smokers and their habits, we have adjusted the financial data from the City of Vancouver Landfill Annual Report (Vancouver Landfill 2013 Annual Report, 2014). Based on this report, the Greater Vancouver area produces 416,947 tons of garbage every year. Table 1, shows all the costs associated with the collection and disposal of this amount. These values were then adjusted to reflect the amount that it costs the city to collect and dispose of the 11 tons of cigarette butts from the Vancouver Campus of UBC (Waste Pick-up, n.d.).

Table 1 – City of Vancouver and UBC Landfill Associated Costs

Item	City of Vancouver	UBC Cigarette Waste
Salaries, Administration, Wages & Fringe Benefits	\$3,980,895.00	\$105.02
Vehicle and Equipment Rental	\$3,966,365.00	\$104.64
Insurance, Taxes, Loan Payments, Utilities, Building Maintenance, Permits & Landscaping	\$1,272,690.00	\$33.58
Recycling	\$545,734.00	\$14.40
Roads and Cover	\$1,240,913.00	\$32.74
Water quality, Gas Management, Ditch Maintenance, Bird Control, Household Hazardous Waste Disposal, etc.	\$605,430.00	\$15.97
Consulting Projects (Leachates Upgrades, Gas, etc.)	\$605,430.00	\$15.97
Sewer and Soil Deposit Fees	\$2,400,084.00	\$63.32
Special Projects	\$92,727.00	\$2.45
Landfill Gas Beneficial Use Revenue	\$297,051.00	\$7.84
Weighscales	\$577,613.00	\$15.24
Totals	\$13,441,711.00	\$411.17

If a better collection program is to be implemented at UBC, at a very minimum, extra man hours and new receptacles would be required. An approximate breakdown of the new collection program costs are detailed in Table 2.

Table 2 – Collection Program Associated Costs

Item	Cost	Notes
Labourers	\$10,400.00	Approximated by estimating an additional 2 man-hours (\$100 (Charge Out Rates, n.d.)) for every pick-up, and assuming 2 pick-ups per week
Collection Bins (Receptacles)	\$40,640.00	UBC has 254 buildings (Chronological Index of UBC Buildings, 2015), an average of 4 bins are to be installed outside of each building at the most popular entrances. Each receptacle costs approximately \$40 in material and installation (please see Appendix F for some information on TerraCycle’s cigarette butt receptacles)(Newbury Port News, 2015).
Total	\$51,040.00	

As highlighted in Table 1, the City of Vancouver spends slightly over \$400 on the disposal of cigarette butts from UBC. In addition, it will cost UBC Building Operations over \$40,000 in receptacle installation costs and approximately \$10,000 per year in extra labour costs. Hence UBC does not have a convincing financial incentive to adopt a collection program for disposing of cigarette butts at the Vancouver Campus.

UBC’s garbage disposal costs were also not available, and as such, an estimation was made based on the fees and charges from the Vancouver landfill. The Vancouver landfill charges \$109 per ton, and with an estimated 11 tons of cigarette waste annually, UBC is paying \$1199 per year to dispose of cigarette waste (Fees and charges at the Transfer Station and Landfill, n.d.).

3.2.2. ECONOMIC ANALYSIS: RECYCLING – COLLECTION + TERRACYCLE

TerraCycle is the only available recycling program for cigarette butts in Vancouver. The TerraCycle Cigarette Butt Disposal Brigade is available to all individuals and institutions. The process of signing up for this program and shipping the recyclables is completely free and is done through their website at www.terracycle.ca.

TerraCycle does not provide any programs for collecting the butts. However, they have receptacles that are available for purchase. Hence, the suggestion of a collection program remains the same for both recycling and non-recycling options. Thus, the total of \$51,040.00 in collection bin and laborer costs from Table 2 will be replicated in the economic analysis of the recycling solution as well.

3.2.3. ECONOMIC ANALYSIS CONCLUSIONS

As shown in Figure 1, disposing of the cigarette butts in a landfill costs UBC nearly \$1200, while sending them off for recycling with TerraCycle would be free. The disposal of UBC’s cigarette butts in a landfill also costs the City of Vancouver over \$400. The collection program will cost UBC close to \$51,000 in the first year regardless of which disposal method is chosen, with a little over \$10,000 annually for every year

after. However, it is worth noting that if TerraCycle is to be partnered with UBC, an agreement similar to the one TerraCycle made with the City of Vancouver could be reached where TerraCycle provides the bins to the University free of cost.

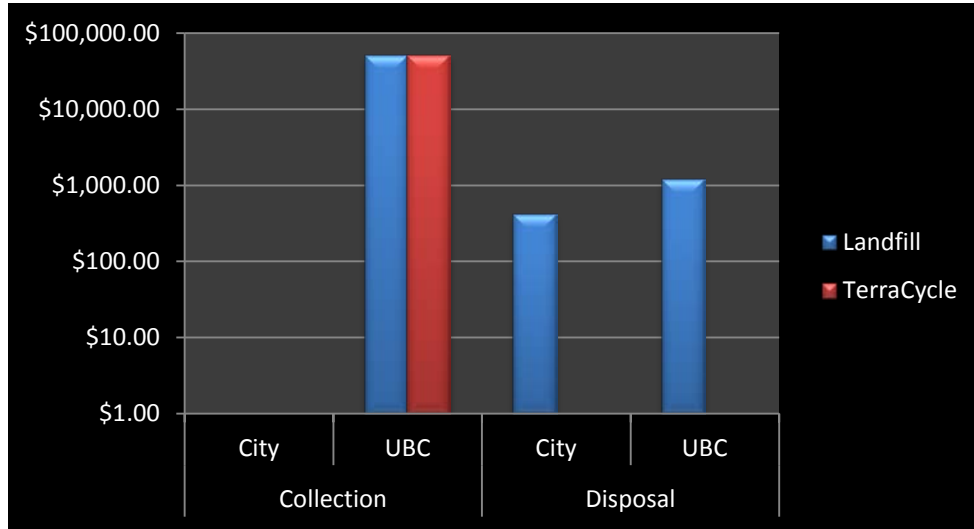


Figure 1 – Cost Comparison for the Landfill Disposal and TerraCycle Recycling Options

Economically, it is not beneficial for UBC to implement a new collection program for cigarette butts on campus. However, it is economically beneficial for the City of Vancouver and for UBC if UBC recycles their cigarette butts with TerraCycle. This would not be possible however, if the butts were not first collected separately from the other waste. One possible option for UBC would be to slowly implement the recycling program to ensure its success before fully committing to it. Furthermore, if an agreement between UBC and TerraCycle could be met to subsidize the cost of the collection receptacles, then recycling would become more and more economically beneficial to the cigarette waste problem at UBC.

3.3. Environmental Analysis

A cigarette butt is made of three main components, the plug, the inner paper wrapper (plug wrap), and the outer paper (tipping paper). The plug accounts for roughly 95% of a cigarette filter and is made of more than 12,000 fibres of a synthetic, plastic-like substance called cellulose acetate. Those fibres have a delustrant (titanium dioxide) applied to them to make the fibres appear white and cotton-like, and they are then bonded together using a plasticiser called triacetin (glycerol triacetate) (Pauly, Mepani, Lesses, Cummings, & Streck, 2002). The plug wrap is made of paper and can be either ventilated or non-ventilated depending on how much air is meant to enter the smoke mix. The plug is attached to the plug wrap using a polyvinyl acetate emulsion. The tipping paper is also made of paper, and is usually printed on to provide a cork-like appearance. This paper covers the filter plug and is formulated to not stick to the lips of a smoker (Cigarette Filters, n.d.).

In the following sections, we will discuss the environmental impacts of each option in detail.

3.3.1. ENVIRONMENTAL ANALYSIS: NOT RECYCLING – COLLECTION + LANDFILL

Cigarette butts are not biodegradable, as they are mostly made of cellulose acetate, a plastic-like substance. Different environmental conditions like the presence of water or sunlight could make the filters degrade over time but it could take tens of years for this process to occur (Are cigarette butts biodegradable, n.d.). Cigarette butts are the most littered item worldwide, with an estimated 4.95 trillion butts littered annually (David Suzuki Foundation, 2013). A cigarette filter is designed to filter out particulates and tar during smoking. If a used cigarette butt comes in contact with water, the chemicals absorbed during smoking leach out into the water. The leachates from smoked cigarette filters cause death in many small marine creatures; 2 butts per liter caused death in the water flea within 48 hours, 20 butts per liter caused death in medaka embryos, and 8 butts per liter caused death for both topsmelt and fathead minnows within 96 hours. Lower concentrations of cigarette butts caused anxiety, lowered the heart rate, and suppressed the development of these marine creatures (Lee & Lee, 2015). Discarded cigarette butts are not only hazardous to marine life, but they are also very taxing on our waste management systems. One million cigarette butts weighs about 375 pounds and takes up 500 liters. These numbers may not seem like too much, but when that is extrapolated to the annual worldwide production of 5.608 trillion cigarettes, it amounts to 2.103 billion pounds and 2.804 billion liters of cigarette butt waste (Register, 2000).

If the cigarette butts are not recycled, they will be sent to a landfill where they release heavy metal leachates, or an incinerator where they release carbon emissions that are harmful to the environment.

Another effect of not recycling cigarette butts is the space that they will take on the planet as garbage and the leaching toxins that sink into the soil and groundwater. The process of transforming raw material into consumer products also adds to the carbon emissions to the atmosphere, so when a product is upcycled, the carbon footprint is lowered, the amount of resource depletion is reduced and less water is withdrawn from the ground. The process of recycling cigarette butts is very similar to recycling plastic (TerraCycle on WPMT (FOX), 2012). Research has shown that the carbon footprint of plastic products similar to cigarette butts could be lowered to 1/10 of the current amount if upcycled (How TerraCycle Helps the Environment, n.d.).

3.3.2. ENVIRONMENTAL ANALYSIS: RECYCLING – COLLECTION + TERRACYCLE

TerraCycle recycles traditionally non-recyclable waste including drink pouches, cookie wrappers, and yogurt tubs into a large variety of consumer products. These consumer products are available at retail stores and on the online TerraCycle shop. TerraCycle recycles cigarette butts into a variety of industrial products, such as plastic pallets. They also re-work any leftover tobacco into tobacco composting (TerraCycle, n.d.).

During the recycling process, the plastic of the cigarette waste is melted down into pellets for industrial use. These pellets are sent to a manufacturer in the northern United States for further processes that result in an alternative pallet to the traditional wood or non-recycled plastic products used across the continent and around the globe. These pallets are aiming to replace the pallet manufacturing industries current raw materials (Ilika, 2012).

Other research has shown that cigarette butts could also be transformed into light-weight bricks that are made by mixing clay with cigarette butts. The properties of this mix is promising and reliable. The leaching of heavy metals from these bricks has also been tested and the results conformed to US and Australian standards (Kadir & Mohajerani, 2011) (Aeslina & Mohajerani, 2012). Another use for recycled cigarette butts is their mixture with acetone and crude petroleum liquid. This mix is shaped and dried to be used as an adhesive, sealer, or an additive to any exterior coating application of finished goods. The resulting product also does not leach chemicals (United States Patent No. US20090113789 A1, 2005). The last method that was investigated was the applications of cellulose acetate to strengthen the mechanical properties of natural rubber. The authors of the study concluded that adding a small amount of cellulose acetate improved the rheological and mechanical properties of natural rubber (Lai, Teo, & Lee, 2014).

TerraCycle encourages users to return the recycled products to them after use, these products will continue to be recycled and will not end up in a landfill or incinerator (Why Send Garbage to TerraCycle, n.d.). TerraCycle ships the cigarette butts to their facility in Toronto, where they are sanitized through a radiation process, shredded and separated. The organic material (tobacco) goes through specialty composting and is made into compost, the cellulose acetate is melted down into pellets for industrial use. According to the founder of TerraCycle, these plastics have been tested at labs and are safe for multipurpose use, however, TerraCycle would rather not risk public safety and only uses the recycled plastics in industrial applications (Ilika, 2012).

3.3.3. ENVIRONMENTAL ANALYSIS CONCLUSIONS

The qualitative analysis above clearly indicates that disposing of cigarette butts in landfills has irreversible effects on the environment, small animals, marine life, and soil and water quality. Conversely, recycling and upcycling cigarette butts not only reduces the carbon footprint of plastic production, it also greatly reduces resource depletion and protects the ecosystem from the heavy metal leachates. From this, we conclude that recycling cigarette butt waste is economically the most sustainable solution.

4.0. CONCLUSIONS AND RECOMMENDATIONS

Based on the triple bottom line analysis performed in the preceding sections, recycling cigarette butts has positive social effects, is more environmentally sustainable, but is less economically viable. The social component of the triple bottom line analysis conducted details the positive social effects that are created from the recycling of cigarette butts through the providing of charitable donations through the TerraCycle program, reducing the health risks from heavy metal leachates that landfill workers are exposed to, and increasing the awareness of the effects of cigarette butt litter. The environmental analysis showed how recycling cigarette butts is less harmful to the ecosystem as the cigarette butts will not be able to leach their contents out into the environment. Further environmental benefits arise from the decreased reliance on natural resources as more products are created with recycled materials. The economic analysis described how the necessary improvement in the collection process could lead to increased costs for the University, however those costs could be subsidised if an agreement could be reached with TerraCycle.

Since UBC is moving towards a greener and more sustainable development plan, we weighed the environmental and social aspects of this analysis higher than the economic aspect. As a result, we strongly recommend partnering with TerraCycle to create a collection and recycling program for cigarette butts on the Vancouver campus for UBC. Utilizing TerraCycle in this path will allow UBC to safely dispose of cigarette butts, while creating a greener society and donating money to the charity of its choice. In addition, forming a partnership with TerraCycle will open new doors to collaboration opportunities that might lead to reducing the initial capital required for the installation of receptacles. Recycling cigarette butts brings UBC one step closer to forming a low carbon emission society that we as Canadians strive for.

BIBLIOGRAPHY

- Aeslina, A. K., & Mohajerani, A. (2012, September 26). Leachability of heavy metals from fired clay bricks incorporated with cigarette butts. *Business, Engineering, and Industrial Applications* (pp. 872-877). Bandung: IEEE. Retrieved February 23, 2015, from <http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6423017>
- Brown, A. (2015, March 19). *Company recycles cigarette butts at Ajax plant*. Retrieved April 2015, from CityNews: <http://www.citynews.ca/2015/03/19/company-recycles-cigarette-butts-at-ajax-plant/>
- Burich, B. (2005, September 19). *United States Patent No. US20090113789 A1*. Retrieved February 19, 2015, from <http://www.google.com/patents/US20090113789>
- Bycraft, S. (2014). *Cigarette Butt Recycling Program*. Richmond. Retrieved from http://www.richmond.ca/__shared/assets/CigaretteRecyclingt_PWT_07231439209.pdf
- City of Vancouver. (2013, November 12). *City and TerraCycle launch cigarette butt collection and recycling program*. Retrieved April 2015, from City of Vancouver: <http://vancouver.ca/news-calendar/cigarette-butt-collection-and-recycling.aspx>
- City of Vancouver. (2014). *Vancouver Landfill 2013 Annual Report*. Vancouver: City of Vancouver. Retrieved from <http://vancouver.ca/files/cov/2013-vancouver-landfill-annual-report.pdf>
- City of Vancouver. (n.d.). *Fees and charges at the Transfer Station and Landfill*. Retrieved April 8, 2015, from City of Vancouver: <http://vancouver.ca/home-property-development/landfill-fees-and-charges.aspx>
- Clean Virginia Waterways. (n.d.). *Are cigarette butts biodegradable*. Retrieved April 2015, from Cigarette Butt Litter: <http://www.longwood.edu/cleanva/cigbuttbiodegradable.htm>
- Clean Virginia Waterways. (n.d.). *Cigarette Filters*. Retrieved April 2015, from Cigarette Butt Litter: <http://www.longwood.edu/cleanva/cigbuttfilters.htm>
- David Suzuki Foundation. (2013, August 8). *Let's get serious about cigarette litter - no ifs, ands or butts!* Retrieved April 2015, from Science Matters: <http://www.davidsuzuki.org/blogs/science-matters/2013/08/-lets-get-serious-about-cigarette-litter-no-ifs-and-or-butts/>
- Fraser, B. (2015, March 31). Interview. (P. Karimi, Interviewer)
- Ilika, D. (2012, June 13). *Recycling firm turns cigarette butts into pallets*. Retrieved April 2015, from Canadian Manufacturing: <http://www.canadianmanufacturing.com/sustainability/recycling-firm-turns-cigarette-butts-into-pallets-67172/>
- Kadir, A. A., & Mohajerani, A. (2011, April). Recycling cigarette butts in lightweight fired clay bricks. *Proceedings of the ICE - Construction Materials, Volume 164*(Issue 5), pp. 219-229.
- Lai, M. K., Teo, H. H., & Lee, J. Y. (2014, December). Recycled Cigarette Filter as Reinforcing Filler for Natural Rubber. (L. Jia, & J. Yu, Eds.) *Applied Mechanics and Materials, Volume 705*(Issue 39), pp. 39-43. Retrieved February 23, 2015, from www.scientific.net/AMM.705.39

- Lee, W., & Lee, C. (2015, March). Developmental toxicity of cigarette butts - An underdeveloped issue. *Ecotoxicology and Environmental Safety, Volume 113*, pp. 362-368. Retrieved from <http://www.sciencedirect.com.ezproxy.library.ubc.ca/science/article/pii/S0147651314005739>
- Moerman, J. W., & Potts, G. E. (2011, May). Analysis of metals leached from smoked cigarette litter. *Tobacco Control, Volume 20*(Supplement 1: The Environmental Burden of Cigarette Butts), pp. 130-135. Retrieved from <http://www.jstor.org/stable/41320124>
- Mulholland, A. (2013, June 21). *Penny for your butts? Vancouver group pushes cigarette-butt recycling plan*. Retrieved from CTV News: <http://www.ctvnews.ca/canada/penny-for-your-butts-vancouver-group-pushes-cigarette-butt-recycling-plan-1.1335827>
- Newbury Port News. (2015, January 27). Health board considers recycling of cigarette butts. *Newbury Port News*. Retrieved April 2015, from http://www.newburyportnews.com/news/local_news/health-board-considers-recycling-of-cigarette-butts/article_adf47386-5e18-5c87-be70-4fcc77e03da1.html
- Pauly, J. L., Mepani, A. B., Lesses, J. D., Cummings, K. M., & Streck, R. J. (2002). Cigarettes with defective filters marketed for 40 years: what Philip Morris never told smokers. *Tobacco Control, Volume 11*(Supplement 1), pp. i51-i61. Retrieved from http://tobaccocontrol.bmj.com/content/11/suppl_1/i51.full
- Register, K. (2000, August). Cigarette Butts as Litter - Toxic as Well as Ugly? *Underwater Naturalist Article, Volume 25, Number 2*. Retrieved from <http://www.cigarettelitter.org/index.asp?pagename=un>
- TerraCycle. (n.d.). *How TerraCycle Helps the Environment*. Retrieved April 2015, from TerraCycle: <http://www.terracycle.com/en-US/pages/how-terracycle-helps-the-environment.html>
- TerraCycle on WPMT (FOX)* (2012). [Motion Picture]. Retrieved from https://www.youtube.com/watch?v=_VdYCDUoqLE
- TerraCycle. (n.d.). *TerraCycle's History*. Retrieved April 2015, from TerraCycle: <http://www.terracycle.ca/en-CA/histories.html>
- TerraCycle. (n.d.). *Why Send Garbage to TerraCycle*. Retrieved April 2015, from TerraCycle: <http://www.terracycle.com/en-US/pages/why-send-garbage-to-terracycle.html>
- The University of British Columbia. (2013). *UBC Sustainability Annual Report 2013: Vancouver Campus*. Vancouver: The University of British Columbia. Retrieved from http://sustain.ubc.ca/sites/sustain.ubc.ca/files/uploads/CampusSustainability/CS_PDFs/PlansReports/Reports/UBCSustainabilityAnnualReport_12-13.pdf
- The University of British Columbia. (2015, March 24). *Chronological Index of UBC Buildings*. Retrieved from UBC Library Archives: <http://www.library.ubc.ca/archives/chrono.html#top>
- The University of British Columbia. (n.d.). *Charge Out Rates*. Retrieved April 2015, from UBC Building Operations: <http://www.buildingoperations.ubc.ca/resources/charge-out-rates/>

The University of British Columbia. (n.d.). *Waste Pick-up*. Retrieved April 2015, from UBC Building Operations: <http://www.buildingoperations.ubc.ca/business-units/municipal/waste-management/waste-pick-up/>

APPENDIX A – TERRACYCLE OVERVIEW

TerraCycle was founded by a Princeton University student, Tom Szaky in the early 2000's. Tom's original idea was to address a major environmental issue by feeding organic waste to worms and using worm feces to develop a quality fertilizer. In the past decade, TerraCycle has expanded globally to help transform waste into useful materials. TerraCycle's cigarette butt disposal program was launched in Canada in 2012. This program's goal is to get as many companies, households, and university campuses enrolled in their program to reduce the number of cigarette butts disposed in landfills and instead, recycled into shipping pallets (TerraCycle's History, n.d.).

TerraCycle partnered up with The City of Vancouver in 2012 to install receptacles across Vancouver, collect the butts and recycle them. This program creates green jobs through two local Vancouver inner-city social enterprises. EMBERS staff will install and maintain the receptacles, while United We Can staff will service the receptacles and ship the cigarette waste to TerraCycle (City and TerraCycle launch cigarette butt collection and recycling program, 2013).

TerraCycle requires customers to sign up online at their website, collect cigarette butts at their own expense and ship them to TerraCycle facilities for free. TerraCycle customers gain points in exchange and these points will be translated to a monetary format and donated to a charity of the collector's choice.

Alternatives

Currently, there is no other cigarette butt recycling or collecting programs in the lower mainland. In 2013, a doctor at Saint Paul's hospital received a grant to compensate cigarette butt collectors for every bag they collected. His program lasted a short time due to the limits of the grant, but was very successful. He sent the collected cigarette butts to TerraCycle for recycling. Similar collection institutes could be facilitated by the city or even private companies to accommodate large sites such as university campuses (Mulholland, 2013).

According to the World Health Organization, there are more than one billion smokers in the world. Scaling this number to UBC's population of about 50,000 students, there are more than 7,000 smokers on campus. Statistics show that Canadians dispose about 8,000 tons of cigarette butts annually, translating this number back to campus' population, UBC smokers produces over 11 tons of cigarette butts every year. With 1 out of 3 cigarette butts being littered, by not collecting and recycling cigarette butts, UBC not only faces the challenges of waste management, it also contributes to the issue of cigarette butts piling up in the landfills. Cigarette butts are not biodegradable, they take about 12 years to break down. Please see Appendix C for more information from TerraCycle's Cigarette Collection Brochure.

APPENDIX B – TERRACYCLE EMPLOYEE INTERVIEW

The following contains interview questions asked and the answers received from a TerraCycle representative named Daniel Caunter.

Steps to recycle cigarette butts

1. What are the steps to recycling cigarette butts?

→ I have attached a brochure and some posters that include the steps for how to participate in the recycling program. (Please see Appendixes C, D, E, and F for the brochure and posters mentioned in this response).

2. How long does each step take?

→ You are able to send in shipments on your own schedule, though you will only receive the TerraCycle points for fundraising for shipments over 3lbs. The timeline for a UPS pickup is a next day pickup. From there, we warehouse the cigarette waste until we have the volume we need to send it to a processor.

3. How much money does it cost?

→ It is free to participate in the Cigarette Waste Brigade, and in fact, the university can use it for fundraising thanks to the TerraCycle points associated with the program.

4. Are there any health risks to the people involved?

→ The cigarette waste can sometimes give off a less than pleasant ash smell and we recommend that collectors ship in their waste in a sealed plastic bag. That said, it is not dangerous to handle.

Program Details

5. What are the negative environmental impacts of cigarette butts?

→ The poster I've attached has some stats on the effect of cigarette waste on storm water systems and litter. This is also something you can research further online. (Please see Appendix D for more information from TerraCycle's Fact Sheet).

6. Where else are you running this program? (What companies, cities, etc.)

→ The Cigarette Waste Brigade is a national program and collectors range from private households to large offices to even city-wide collection programs, like the one in Vancouver.

7. Are there any other recycling programs that you know of? What are their advantages/disadvantages?

→ The only other program that I'm familiar with actually uses our Brigade to process the cigarette waste they collect.

Miscellaneous

8. Are there any other associated costs that UBC will have to pay?

→ Participation in the program is free, but TerraCycle offers permanent collection bins that can be installed around campus and those would have a cost associated with them. There may also be an internal cost (i.e. time) for university or student personnel to package the waste and send it back to TerraCycle.

9. Do you have any recommendations to better help the process of recycling/collection?

→ Yeah, set up a campus-wide collection program with the Cigarette Waste Brigade!



RECYCLE YOUR CIGARETTE WASTE WITH TERRACYCLE

NOW YOU CAN RECYCLE CIGARETTE WASTE & FUNDRAISE TOO!

It's free and easy to sign up and start collecting. You'll receive **\$1** (equal to 100 points) for each pound* (453.6 g) you send us. The money you raise can be donated to a charity or non-profit of your choice.

HOW DO YOU GET STARTED?

1. Sign up for an account on terracycle.ca.
2. Join the Cigarette Waste Brigade®.
3. Collect (you can send cigarette foil and plastic packaging waste, too).
4. Pack your waste in a plastic bag and put it in a cardboard box.
5. Send the box to us free of charge.

HOW DO YOU GET OTHERS INVOLVED?

- Share this program with your corporate "Green Team."
- Forward this brochure to your organization's janitorial staff.
- Tell your local BIA, anti-litter group, city council or anyone else you think would be interested in this initiative.



The cigarette waste you send us will not only be diverted from landfill, but it will be recycled into industrial products, such as pallets (pictured above).

THE FACTS ABOUT CIGARETTE WASTE:

416,955

cigarette butts were cleaned up during the annual Great Canadian Shoreline Cleanup™ in 2012, making it the number one pollutant recovered from our shores.

8,000 tons

of cigarette butts are dropped by Canadians each year, the majority within 10 feet of an ashtray.

12 years

Cigarette butts are not biodegradable and can take up to 12 years to break down.

*We will recycle all cigarette waste we receive. To qualify for points, you must send us a minimum of 3 lbs

Appendix D – TerraCycle’s Cigarette Fact Sheet



THE CIGARETTE WASTE BRIGADE®

The World's First Global Solution for Tobacco-Related Waste

THE PROBLEM

"1 cigarette butt can contaminate 1 litre of water"

- Jacob, Gina. "Cigarette Butts Toxic to Marine Life." San Diego State University (May 1st, 2009)

"Only 10% of cigarette butts are disposed of in ash receptacles."

- iQ Research & Consulting, Keep America Beautiful Pocket Ashtray Study (January 2008)

"1.69 billion pounds of cigarette butts wind up as litter worldwide per year."

- Carlozo L.R. "Cigarettes: 1.7 billion pounds of trash." Chicago Tribune. (June 18th, 2008)

"1 in 3 cigarettes end up as litter."

- preventcigarettelitter.org

THE SOLUTION



1. Participants send cigarette waste to TerraCycle®



2. Filters are sterilized using gamma radiation followed by testing for bio-burden (# of bacteria living on surface)



3. Filters are shredded



4. The tobacco is separated from the shredded filters



5. Tobacco goes to non-food composting



6. The shredded filters are blended with other recycled material and then pelletized to be used for injection molding or extrusion

The Cigarette Waste Brigade is a free recycling program available to any interested party that would like to recycle tobacco-related waste (including used filters, foil, and plastic packaging). Participants receive 100 points (equal to \$1) per pound of waste. The points can be used to purchase charity gifts or converted to a cash donation to a charity or non-profit of choice. The collected waste is recycled into plastic pallets (aka skids) and other items for industrial use.

By making products from recycled cigarette waste, TerraCycle will not only reduce the amount of litter worldwide, but also reduce the need to use wood or virgin plastic to make commonly used industrial products. The organic parts of the waste—the paper and remaining tobacco—are composted.

Join the Cigarette Waste Brigade by visiting terracycle.ca

Since the launch of the program in May 2012, more than 70 million cigarette butts have been collected worldwide. There are more than 10,000,000 people currently collecting cigarette waste through the TerraCycle program at more than 8,000 locations across Canada, the US, Hungary, Germany, Switzerland, France, Japan, and Australia.

Appendix E – TerraCycle’s Main Cigarette Poster



Cigarette Waste BRIGADE®

TerraCycle® is working with people around the world to help eliminate the idea of waste.

1 collect

- Sign up at terracycle.ca.
- Join the Cigarette Waste Brigade.
- Start collecting cigarette waste, including
 - all parts of extinguished cigarettes
 - cigarette filters
 - partial cigarettes
 - cigar stubs
 - outer plastic packaging
 - inner foil packaging
 - rolling paper
 - ash



2 ship

- Dump the cigarette waste into a re-sealable plastic bag.
- Go on your TerraCycle account and click on "SHIP US YOUR WASTE".
- You will receive an e-mail with the shipping label attached.
- Affix the pre-paid postage label to your box of cigarette waste and call UPS for a next business day pickup.



3 recycle

- The cigarette waste will be recycled into a variety of industrial products, such as plastic pallets, and any remaining tobacco will be re-worked into tobacco composting.
- You earn \$1 (equal to 100 points) for the charity of your choice for every 1 lb (453.6 g) of cigarette waste you send in. (*To earn points, you must send in a shipment of at least 3 lbs.)



For more information visit www.terracycle.ca

One hundred TerraCycle points will be awarded for each pound collected. TerraCycle points can be redeemed for a variety of charitable gifts or payment of \$0.01 per point to the non-profit organization of your choice. TerraCycle®, the TerraCycle Logo® and Brigade® are all property of TerraCycle, Inc. used under license. ©2013.

Appendix F – TerraCycle’s Receptacle Installation Guide



RECTANGULAR POLE-MOUNTED RECEPTACLE

Capacity:

- 700 cigarette butts

Dimensions:

3 1/8" x 3 1/8" x 19" high

Construction:

- Fire-safe aluminum
- 100% rust-resistant

Security:

Lockable

Ash Liner:

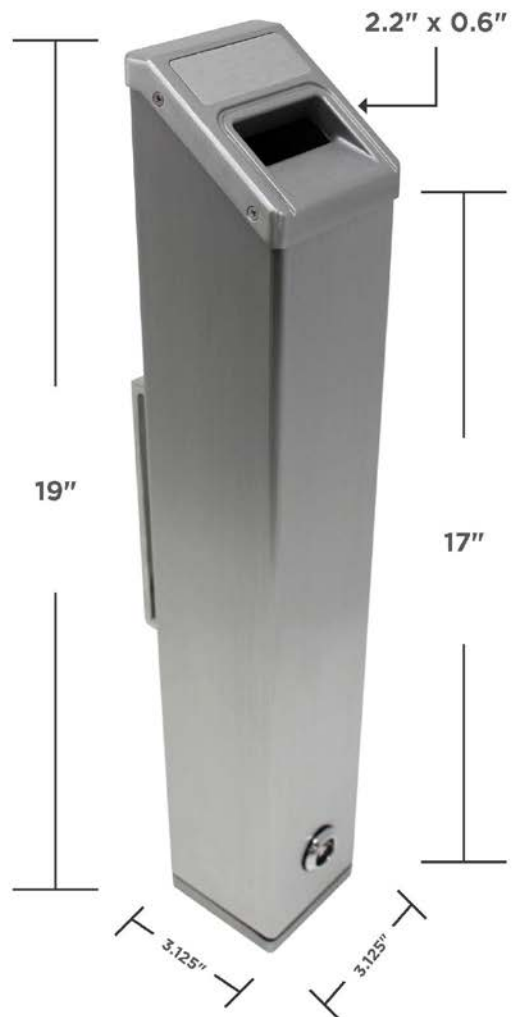
No

Installation:

- Bolted (included)
- Steel-banded
(recommended and instructions included)

Special Features:

- Rain gutter to reduce rain water into the unit
- Easy installation and servicing
- Weather resistant
- Customization available (vinyl stickers)





STEEL-BANDING INSTALLATION

MATERIALS NEEDED:

Purchasable: http://www.uline.com/BL_2905/Stainless-Steel-Strapping

ITEM #	DESCRIPTION	QUANTITY
S-14377	5/8" Stainless steel banding	Varies depending on number of receptacles and width of post
S-14378	5/8" Banding seals	Two seals per receptacle
H-1273	Tensioner to tighten bands around post	Varies on number of individuals installing

INSTALLATION INSTRUCTIONS:

1. Three vinyl stickers should be applied to each receptacle (these stickers are customizable)
2. Check each lamp pole or post against the installation map (varies per location)
3. Measure 40 inches from ground level. The bottom of the receptacle should be 40 inches from ground level when installed
4. Ensure that the receptacle is vertically level and the front faces the sidewalk
5. Measure the stainless steel band on the circumference of the pole
6. Pass the band through the top portion of the mounting bracket
7. Tighten the band
8. Repeat the steps above with the lower band
9. Check that the receptacle is tightly mounted by alternately placing light pressure against the sides of the receptacle
10. Cut off the excess banding



SERVICING INSTRUCTIONS

INSTRUCTIONS:

1. Receptacles must not reach a fill rate of more than 85% (safety precaution).
2. Receptacles must be closed securely after emptying.
3. Place a bag or bucket beneath the receptacle, raising the rear edge at least two inches behind the receptacle between the receptacle and the pole.
4. Hold the bag/bucket with one hand.
5. With the other hand unlock the receptacle door with the receptacle key. Please note that the servicer will be required to keep and safeguard the receptacle keys.
6. Tap the side of the receptacle gently to dislodge any material clogged inside.
7. Close and lock the receptacle.
8. Aggregate all collected cigarette waste and seal in trash bags.





RECEPTACLE IN-USE EXAMPLES



Pole-mounted receptacle secured with bolts vs. bands



A bottom latch of the receptacle opens using a skeleton key for easy servicing



Pole-banded receptacle installed for the Vancouver Cigarette Recycling Program (Customized receptacle sticker)



Pole-banded receptacle installed for the New Orleans Cigarette Recycling Program (Customized receptacle sticker)

