

**UNIVERSITY OF WATERLOO  
DEPARTMENT OF ENVIRONMENTAL STUDIES**

**ALKALINE BATTERY RECYCLING AT THE  
UNIVERSITY OF WATERLOO**

**Prepared for**

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**ERS 317**

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# Alkaline Battery Recycling at the University of Waterloo

Group: Julia Cushing, Nina Quan, Brent Thornton

## Executive Summary:

Battery Recycling is an issue that is becoming more prominent in today's society. People are becoming more aware of the hazards of disposing of batteries ~~into landfills~~. This project's goal was to determine the feasibility of implementing a battery recycling program at the University of Waterloo, in which both staff and students could one day participate.

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Three different methods were used in order to determine the feasibility of such a program. First, a literature review was conducted to learn of the various hazards of batteries. Second, a battery audit was carried out to estimate the level of campus-wide participation a battery recycling program, and also to determine the extent to which disposable batteries are used amongst students. Lastly, expert interviews were ~~performed~~ to guide the project and gain insight into the various issues related to batteries and recycling them.

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## Research Question:

Is a battery recycling program for household alkaline batteries a feasible option for the University of Waterloo?

Rationale:

Disposable batteries are used frequently in North America. They can be used in many electronics used in everyday life from stereos to video games, to remote controls. On average, North American households produce 1.2 pounds of disposable battery waste each year, that equates to 200 000 tons of batteries on the entire continent of North America annually (*Raw Materials Company, 2005*). Unfortunately, there aren't widely used programs for household battery recycling since municipal governments do not usually include batteries in local recycling programs; and therefore, the majority of these batteries end up in landfills. The reason household batteries aren't included in local recycling programs is because they aren't considered 'hazardous' materials (Patti Cook, 2005). The amount of heavy metal waste that is being disposed of in municipal landfills equals the capacity of ten Great Lake Freighters (*Raw Materials Company, 2005*)

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There are many reasons why battery recycling is beneficial for environmental as well as, economic reasons. Although the effects of thousands of tonnes of heavy metals in municipal landfills has not been realized as of yet, it is dangerous to continue taking this risk by dumping hazardous metals in landfill sites (*Raw Materials Company, 2005*). It is essential to be proactive in dealing with battery waste. It would cost each household only \$2.00 to responsibly dispose of these batteries by recycling them at an appropriate facility. When the metal content of batteries is recycled, it is possible to save between 45-90% in energy costs alone (*Raw Materials Company, 2005*).

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In order to avoid the negative environmental effects of dumping thousands of tons of batteries and heavy metals into municipal landfills it is essential to implement an on-campus battery recycling program.

### Objectives:

The focus of this project is on the feasibility of implementing a household alkaline battery recycling program at the University of Waterloo. The goal of our research is to determine if it will be economically possible to collect household batteries on campus from staff and students, and have them recycled ~~through~~ an Ontario recycling program.

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### Methods:

~~Our method of triangulation included firstly~~ expert interviews with John Strick, ~~Waste Management Officer with the Regional Municipality of Waterloo~~; and Patti Cook, the waste management coordinator for the University of Waterloo.

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Second, the group conducted a literature review to address the issues involved with batteries, and the process of recycling them. A review of relevant journal articles, books and websites were explored. Some questions that the group aimed to answer are:

- What are the hazards involved with the disposal of batteries in landfills? Where can batteries be processed? Is the processing company reliable?
- How and where will the batteries be collected?

- How many batteries would need to be collected in order for recycling to be economically feasible? How are batteries transported to the processing facility, and how much does it cost?
- Would a battery recycling program be accepted within the University of Waterloo Community and would students and staff willingly participate?
- What are the specifications of the processing company for receiving the batteries?

Third, the group planned and implemented a battery audit. This involved setting up a battery drop off box at Columbia Lake Village, one of the University of Waterloo residences. From the battery audit, the group hoped to get an estimate of the expected participation in the battery recycling program, which is directly linked to the economic feasibility of the program itself.

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#### Assumptions:

The first assumption the group made is that a large portion of the University of Waterloo population uses alkaline batteries, and therefore, a battery recycling program would be beneficial to the University.

The group is also making the assumption that batteries in landfills pose environmental threats, and that recycling batteries is the best option next to rechargeable batteries. Part of the literature review will be focused on validating these assumptions.

### Boundaries:

The scope of this research project is the community of the University of Waterloo. The group is addressing the issue of battery recycling within the University among the students and staff. In order to get an estimate of the amount of batteries used at the University, the group narrowed the project's focus to one residence, Columbia Lake Village.

### Limitations:

The major limitations of the project were the number of professors that could participate in the interviews. There were not as many waste experts among professors as first thought. Furthermore, the group was also limited by the willingness of some participants to take part in the interviews. It was often difficult to receive responses to e-mailed questions.

Lastly, although the group did advertise the battery drop off box, the audit was limited by the amount of students who read the newsletter and the e-mail that explained about the project and how to participate. Students who did not read the advertisements wouldn't have known about the project and therefore, would not have participated.

### Literature Review:

Annually, 200, 000 tons of household batteries are added into landfills in North America [reference?](#) and unfortunately there is little scientific data about any health hazard or

environmental hazards. This large quantity of household batteries composes the greatest source of mercury in the municipal waste stream. [Source?](#) Batteries are produced in various forms and made of materials that are hazardous such as mercury, cadmium, silver, lead, lithium, manganese, nickel and zinc. There are two types of batteries. The batteries which cannot be reused and recharged are considered as primary type and the ones which can be reused are considered as secondary or rechargeable type. Table 1 presents the typical types of household batteries (Handling Wastes: Household Batteries).

**Table 1: Typical Types of Household Batteries** (Handling Wastes: Household Batteries)

<b>Primary Batteries (Non-rechargeable)</b>		<b>Common Uses</b>
Alkaline	Cassettes players, radios, appliances	
Carbon-zinc	Flashlights, toys, etc.	
Lithium	Cameras, calculators, watches, computers, etc.	
Mercury	Hearing aids, pacemakers, cameras, calculators, watches, etc.	
Silver	Hearing aids, watches, cameras, calculators	
Zinc	Hearing aids, pagers	
<b>Secondary Batteries (Rechargeable)</b>		<b>Common Uses</b>
Nickle-cadmium	Cameras, rechargeable appliances such as portable power tools, hand held vacuums, etc.	
Small sealed lead-acid	Camcorders, computers, portable radios and tape players, cellular phones, lawn mower starters, etc.	

Rechargeable batteries provide a longer life span and thus use fewer batteries compared to primary batteries. However, heavy metals such as nickel-cadmium are still present in the rechargeable batteries. It is strongly recommended that rechargeable batteries be recycled if possible when disposing them to reduce the number of batteries entering the waste stream. If the rechargeable batteries are not effectively recycled, the rechargeable

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batteries can increase the amount of heavy metals entering the waste stream (Handling Wastes: Household Batteries). Rechargeable batteries are recyclable in the Regional recycling program.

Although records have shown that today's household batteries are 99.7% mercury free, the number of older batteries with heavier concentrations of mercury that remain in homes is in the billions. According to the United States (U.S.) Environmental Protection Act (EPA), household batteries are believed to generate significant concentrations of heavy metals in landfills and air emissions in municipal mass-burn or waste – to – energy facilities. The few options available for disposal and recycling of household batteries indicates that these problems are largely ignored by local government (Local Government Household Battery Collection Programs: Costs and Benefits).

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Because batteries are made from various chemicals such as cadmium, mercury, copper, zinc, lead, manganese, nickel, and lithium, there are potential environment problems or hazards can be produced if batteries are not properly disposed. Lakes and streams can be polluted as the metals vaporize into the air when batteries are burned. Disposing batteries into landfills can contribute to heavy metals that may potentially leach from solid waste landfills. The environment and water are exposed to lead and acid generating from batteries (Handling Wastes: Household Batteries)

In Canada, the three most common household batteries sold are: alkaline batteries, zinc carbon and zinc chloride batteries, and nickel-cadmium rechargeable batteries (Battery Fact Sheet). Necessary actions were taken from the household battery industry to

improve the environmental effects from disposing household batteries. Mercury from alkaline and zinc carbon are eliminated from the battery production process. Selling mercuric oxide batteries has been banned from the market. Lastly, recycling programs for nickel-cadmium rechargeable batteries has been introduced globally (Battery Fact Sheet).

Having identified the significant potential health effects, a variety of collection programs have been designed. The difficulty with household battery collection programs is related to how dangerous the public believes battery contamination is, and furthermore, the high costs of collection, and the willingness of elected officials to support or sponsor collection efforts (Local Government Household Battery Collection Programs: Costs and Benefits). As well, perhaps the fact that all the batteries have to be separated for recycling.

Local governments or communities are often the people who initiate the collection of household batteries program. They are the ones who decide on how batteries are collected and managed. The choices are either to dispose of collected batteries at hazardous waste facilities or to recycle them. Long term storage will be a viable option to be considered if the community or the local government is unable to locate a waste disposal or recycling facility to accept the collected batteries. It is often found that national and provincial governments do not provide local assistance in finding recycling markets for household batteries (Local Government Household Battery Collection Programs: Costs and Benefits).

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Few collection programs are done in the U.S.A. and ranked as an effective method of managing household batteries. On-going curbside recycling collection programs are one of them. The process consists of waste batteries being separated from bins, bags or boxes that residents place in collection containers outside their homes. The advantage of this program is the high level of participation rates from the public. However, this program is costly. Another method is a battery drop-off. Battery drop-off collection sites are at retail locations and various other places. Drop-off collections allow communities to conduct battery collection programs while avoiding the labor and equipment investment costs associated with curbside collection operations. This method has the advantage of public education as well as an inexpensive means of collecting and targeting batteries. In addition, sometimes household batteries are collected by some private or civic groups. “This collection has not been highly successful in removing a significant number of household batteries from the waste stream mainly because collections often end up with a mixture of batteries, many of which are minimally harmful to the environment and/or are costly to separate for recycling/metals reclamation” (Local Government Household Battery Collection Programs: Costs and Benefits).

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In summary, there is no set standard controlling household batteries from entering the waste stream. Pilot programs and other techniques based on trial and error methods have been developed and tested. There is no single solution to collecting, storing, or recycling all types of household batteries. From the literature research, there is very little, or no profit in recycling household batteries including expenses which can be covered. Don't understand the sentence? No set standards for storage or disposal of

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household batteries have been identified and yet methods of storage and disposal vary widely. Opinions vary about which is the best collection method, storage method, and disposal method. “The differences in programs depends upon the goals and objectives of the county, the program administrator, public knowledge and support, provincial support, and the available resources and budget constraints” (Local Government Household Battery Collection Programs: Costs and Benefits).

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#### Expert Interviews:

The interview aspect of our triangulation method involved three interviews; one with John Strick, Waste Management Officer with the Regional Municipality of Waterloo, responsible for institutions; and two with Patti Cook, the waste management coordinator for the University of Waterloo.

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Our first interview with Patti Cook was designed to discuss various strategies for the battery audit. The goal was to gain insight into the best way to approach an on-campus audit that would lead to clear information on the feasibility of a battery recycling program. We discussed various audit strategies, including targeting residences, faculties, or common areas such as the Student Life Centre. This information proved to be essential for the recommendations section of the report as we discussed with Patti Cook the various advantages and disadvantages of each audit method. Furthermore, we discussed the necessity of such a battery recycling program on-campus, this would give us an indication of the potential participation in an audit.? How does the necessity of a recycling program give us an indication of participation? We were informed that Patti

consistently receives e-mails ~~from~~ members of the University faculty ~~inquiring what they~~ should do with their spent batteries. Additionally, we were shown ~~a~~ box full of batteries that people have contributed to in the past three months, simply because, Patti told us, people know they shouldn't throw out batteries, but they don't know what else to do with them. We took this as an indication of the validity of our project. Would be interesting for a future study to look at why people believe or where they learned that batteries shouldn't go in the garbage.

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Towards the end of the interview, the group decided to target one residence for the battery audit. This would hopefully give us some insight into the participation we would receive from students if the University was to implement a battery recycling program. Patti provided us with a blue recycling box to make the audit look more legitimate to students who passed by in the hopes of attracting their attention.

The second interview was with John Strick. This interview was conducted through email for John's convenience, as he could answer our questions when he had the opportunity.

In our first email we began by stating who we were and ~~that~~ we were researching the feasibility of recycling household batteries on campus. We continued the email by asking some questions we hoped he could answer:

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Might be better in an appendix?

1. Are there any current programs for recycling household batteries? If so, what sort of things does it entail (ie. what type of batteries do they take? what are the costs?, etc.)

2. Are there drop boxes for battery collection located in Waterloo? If yes, where are they and how are they advertised? Have you come across techniques to get the information across that work better than others?
3. Approx. how many batteries do you recycle per year?
4. Are there programs for collecting batteries at schools and recycling them? If not, would the Region be interested in participating in such a program?
5. We are testing a box collection at one or more residences, what should we do with our collected batteries?
6. How much would this cost, and how many batteries would you need in order for this to be economically feasible?
7. What is involved in recycling a battery?
8. What is the final product after recycling?
9. What is done with the waste?
10. Can you resell the after product?
11. Are some batteries better than others for recycling?

John was unable to answer the majority of our questions. He responded with what he could though. He explained that the city does collect "household" batteries at their Household Hazardous Waste facility which is open daily at the Waterloo Landfill Site. They take all types of batteries from rechargeable to alkaline. This informed the group that household battery disposal is a concern to the Region, and they are actively pursuing means to direct batteries away from the landfill. The Region uses a company called Hotz Environmental to take the batteries to the recycling facility. The recycling facility is

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located in Hamilton, Ontario and receives hazardous waste from all over North America, (Hotz Environmental, 2005).

He informed us that there is a recycling program for rechargeable batteries in the Region. There are a number of rechargeable battery drop-off boxes throughout the city. The group realized from this information, that there may also be a need for battery recycling programs of all kinds at the University.

The second interview with Patti was designed to discuss the results of the battery audit, and further, to gain insight into the feasibility of implementing a battery recycling program from the results of the audit. We discussed a company the group researched which conducts recycling for household alkaline batteries, called Raw Materials Company (2005). The Raw Materials Company collects household alkaline batteries as well as several other types of batteries; furthermore, it is the only facility in North America permitted to recycle every type of battery. The Raw Materials Company charges \$129.00 for a collection box which is designed for the safe storage and shipment of spent batteries. Once the 20Kg box is filled, the company will transfer the box to their recycling facilities (*Raw Materials Company*, 2005). We discussed this battery recycling option for the school, but were informed that the school pays approximately \$75 for the removal of 1 tonne of garbage. Therefore, when compared to the cost of recycling the collected batteries, disposing of them in a landfill is far less expensive. This may increase the difficulty of implementing a battery recycling program on-campus.

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We also received information from Patti regarding the current battery recycling program at the University for 'hazardous' batteries. Alkaline batteries are not included in this program because they are not considered 'hazardous'. Batteries classified as "hazardous" (NiCad and HiHalide and Mercury), for example car batteries. The recycling programs for NiCad, and NiHalide costs \$2.70 per Kg and recycling programs for Mercury-containing batteries are \$19.00 per Kg. Per 20Kg, the amount of batteries that the Raw Materials Company will collect, recycling alkaline batteries would cost less than recycling for hazardous batteries.

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#### Battery Audit:

The battery audit was planned for the weeks of March 7<sup>th</sup> 2005 to March 21<sup>st</sup> 2005. To inform the residents about the battery collection project, a section of the Columbia Lake Village March Newsletter was added to explain what the battery audit was about, why it was important, and how to participate. Furthermore, an e-mail was sent to all the residents at Columbia Lake Village reminding them of the battery audit approximately one week after the audit began. A recycling box was set up in the CLV community centre with a poster above to advertise the battery audit, and two other posters (Appendix A) were hung on the walls to increase awareness of the project. One poster was placed in the laundry room, which is an area of high traffic and would be very effective in advertising to a wide range of residents.

The battery audit proceeded for two weeks. At the end of the two weeks, the batteries were collected, counted, and weighed. In total, 44 batteries were collected from the 400

students that live at Columbia Lake Village over the two week period. Although the battery recycling box was intended for alkaline batteries, various types of batteries were collected, such as button cell batteries, and rechargeable phone batteries. This informs the group that there is a need for recycling of many kinds of batteries at the University.

**Table 2: Analysis of Batteries Collected During the Audit**

<b>Type</b>	<b>Number</b>	<b>Weight (g)</b>
C Batteries	9	625
9 Volt	3	115
AA	14	280
AAA	10	70
Button Cell	7	Does not register
Rechargeable phone battery	1	50
<b>TOTAL</b>	44	1140

### Conclusions and Recommendations:

Recycling household batteries is an issue that is becoming more prominent in today's society. The Region has already implemented a battery recycling program for household batteries, this indicates a level of awareness at the regional level. The group mission was to determine the necessity for a battery recycling program on-campus, and to increase the level of awareness at the University of Waterloo regarding the harmful effects of batteries when disposed of improperly.

Through the battery audit, and expert interviews, it was learned that there would be participation in a battery recycling program on-campus. However, at this time, there is not enough information on the amount of participation, and as a result, the success of a campus-wide battery recycling program is what? Questionable?. Therefore, at this time, due to the high cost of participating in a battery recycling program, compared to the cost of disposing of waste in landfills, and due to the uncertainty of the level of participation campus wide, it is not feasible to implement a battery recycling program.

Some recommendations regarding how to obtain more information on participation, and how to lower the cost of recycling batteries are as follows:

1. Conduct a campus wide audit over an entire term to gain insight into the amount of potential participation throughout the university.
2. Conduct a survey. From the expert interviews, we learned there was clear concern regarding battery disposal at the University. A survey could help determine how

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many people are aware of the hazards associated with battery disposal and how many people would be willing to participate in a battery recycling program.

3. Discuss a partnership between the Raw Materials Company and the niversity to help lower costs.

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4. Discuss a partnership with the city to determine if this could also lower costs.

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It is hoped that once this information is gathered, the University of Waterloo will have a better understanding of the feasibility of implementing a campus-wide battery recycling program. In the best interest of the environment, if a battery recycling program is feasible, it would be beneficial for the niversity to invest in such a program such as the one run by the Raw Materials Company.

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## Appendix A: Battery Recycling Poster



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# WHAT DO YOU DO WITH YOUR HOUSEHOLD BATTERIES?

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Batteries are a unique product comprised of heavy metals such as nickel cadmium, alkaline, mercury, nickel metal hydride and lead acid. If batteries are not properly discarded, they can threaten our environment. The following are potential problems or hazards batteries may produce:

- Pollute the lakes and streams as the metals vaporize into the air when burned.
- Contribute to heavy metals that potentially may leach from solid waste landfills.
- Expose the environment and water to lead and acid.
- Contain strong corrosive acids.

**Your Battery Drop Off Box Is Located:**



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batteries in landfills”, Journal of Power Sources 57, page 9-12

Good work.

Great Poster!

A little more editing would be good.

It might have been interesting to extrapolate the data of the number of batteries and  
residents in CLV, to the university.

and to use the number of batteries purchased by the university (which you were going to  
use?) to indicate significance of the battery issue.