Waste Management

Analysis and Opportunities Regarding Waste within the Frontenac Arch Biosphere Reserve

ENSC 430* Honours Project in Environmental Sustainability

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In association with the Frontenac Arch Biosphere Reserve

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Executive Summary

In evaluating the sustainability of the Frontenac Arch Biosphere Reserve (FABR), this report has investigated the current waste management practices within the region and has subsequently identified opportunities for improvement within the biosphere.

Looking at only municipal solid waste (MSW), the report quantified all landfills located within the biosphere and examined what materials were accepted at each site. Furthermore, South Frontenac Township (SFT) and the Township of Leeds and the Thousand Islands (TLTI) were investigated in detail with regards to their landfill practices, waste technologies and strategic waste management plans. Using an attribute table and ArcGIS 10 mapping, the study found that while most landfills accepted MSW and separated basic recyclable materials, there was little to no organic waste diversion across the FABR. Within the two townships of interest, waste management strategies highlighted important differences such as the implementation of curbside waste pickup, the ability to invest money in to one or more landfills and future plans for organic waste diversion. The predominant theme facing rural communities in the FABR is the challenge to implement new technologies while maintaining financial responsibility to their residents.

The second portion of the study focused on two opportunities for townships within the FABR to improve their waste management practices. Firstly, this study's creation of an attribute table and several ArcGIS 10 maps was the first true consolidation of landfill information for the FABR. As a result, it could be distributed and studied by townships to gain a better understanding of their region's waste management practices in hopes that it would spur positive improvements within each township. Secondly, waste diversion was investigated to minimize the amount of waste entering landfills within the region. At the source, the education of residents about proper waste management practices was identified as being critical to sustainable waste disposal. After waste collection, the study identified the region's lack of organic waste diversion and showed that with the proper funding and inter-township support, a biogas facility could be set up to not only dispose of organic waste but also provide electricity for the region.

3) Table of Contents

1) Acknowledgements 3
2) Executive Summary 4
3) Table of Contents 5
4) List of Figures 7
5) List of Tables 8
6) Introduction 9
6.1 Overview 9
6.2 Objectives 10
7) Scope 12
8) Indicators 12
8.1 Broad Level and Case-specific Indicators 12
8.2 Indicator selection 14
9) Methods 15
9.1 Introduction 15
9.2 Resources 15
9.2.1 Data Collection 15
9.2.2 Group workshop 15
9.3 Attribute Table, Key Statistics Table and GIS Map 16
9.4 Biogas Research 16
10) Results 17
10.1 Group Workshop 17
10.2 Symposium 17
10.3 Attribute Table 18
10.4 ArcGIS 10 Maps 19
10.5 Case-Specific Results 21
11) Critical Comparison of South Frontenac and Leeds and the Thousand Islands 23
12) Opportunities 31
12.1 Landfills Attributes 31
12.1.1 Introduction 31
12.1.2 Attribute Table 31

12.1.3 GIS Map 32
12.1.4 Comparison of Large and Small Landfills 33
12.2 Waste Diversion 36
12.2.1 Source Diversion: Education 36
12.2.2 Collected Waste Diversion: Biogas 38
12.2.2.1 Introduction 38
12.2.2.2 Importance 40
12.2.2.3 Feasibility 40
12.2.2.3.1 Biogas Implementation 40
12.2.2.3.1.1 Case Study of Ledgecroft Farm 40
12.2.2.3.1.2 Case Study: Fraser Valley, BC 42
12.2.2.3.2 Biogas Funding 45
12.2.2.3.3 Interest 46
12.2.2.3.3.1 South Frontenac Interest 46
12.2.2.3.3.2 Leeds and the Thousand Islands' Interest 46
13) Recommendations 47
13.1 Recommendations for the SFT and TLTI 47
13.2 Recommendations to FABR 47
13.3 Recommendations to Future ENSC 430* Groups 48
14) Conclusion 49
15) Works Cited 50
16) Appendix 52
16.1 Interview format and questions 52
16.2 Group Workshop 55
16.3 Waste Management Information Brochure (Screenshot) 58
16.4 Raw Data 59
16.4.1 Landfill Data 59
16.4.1.1 Landfill Flow Chart (Jarrett et al., 2009) 59
16.4.1.2 Landfill Attribute Table (Screenshot) 60
16.4.2 Comparison of SFT and TLTI Waste Management Strategies 62
16.4.3 ArcGIS Landfill Map (Screenshot) 63
16.5 Ethics Form 64

4) List of Figures

Figure 1: Attribute Table for the South Frontenac Township . . . . . .Page 18

Figure 2: Attribute Table for the Township of Leeds and the Thousand Islands 19

Figure 3: Attribute Landfill Map 20

Figure 4: Attribute Table Embedded in ArcGIS Map 20

Figure 5: Landfills and Associated Major Cities in and around FABR 33

Figure 6: South Frontenac Waste Generation Graph 2005-2010 34

Figure 7: Waste Audit Graph for Leeds and the Thousand Islands 35

Figure 8: Schematic illustration of the degradation of organic material 40
by anaerobic microorganisms in to biogas

Figure 9: Biogas Facility from Ledgecroft Farm, Ontario 42

Figure 10: Geographic location of Fraser Valley, British Columbia 43

Figure 11: Results of the organic waste survey performed by Electrigaz 44
Technologies for Fraser Valley, BC

Figure 12: Organic waste survey results in Fraser Valley, BC 45

5) List of Tables

Table 1: Summary of indicators and their respective metrics . . . . . .Page 13

Table 2: Site statistics of all landfills in operation within the South 21
Frontenac Township

Table 3: Waste quantities of selected landfills in operation within the South 22
Frontenac Township (SFT) as well as the SFT as a whole in 2010

Table 4: Landfill statistics from the Lansdowne landfill within the Township 22
of Leeds and the Thousand Islands in 2009

Table 5: Ley MSW statistics of the South Frontenac Township and the Township 23
of Leeds and the Thousand Islands

Table 6: The amount of waste that is diverted through the Blue Box 25
program in the South Frontenac Township

Table 7: Quantity of recyclables collected at individual landfills within 26
the Township of Leeds and the Thousand Islands in 2010

6) Introduction

6.1 Overview

Knowledge of waste management practices is the first step in creating a more sustainable waste management society. Reporting and subsequent development of waste management schemes will allow areas studied to become more sustainable by reducing the ecological footprint that its citizens have on their global environment. It is important to incorporate sustainability into waste management frameworks in order to preserve our Canadian land and resources. This report adopts the definition of sustainable waste management from Kevin Lidster's Sustainable Waste Management report (2001), which states:

> "Sustainable Waste Management can be defined as using material resources efficiently to cut down on the amount of waste produced, and, where waste is generated, dealing with it in a way that actively contributes to the economic, social and environmental goals of sustainable development."

The goal of this report is to analyze and suggest improvement for current waste management practices within the Frontenac Arch Biosphere Reserve (FABR), focusing on South Frontenac Township (SFT) and the Township of Leeds and the Thousand Islands (TLTI). The FABR is a recognized area in southeastern Ontario that covers about 2700 km^2 and includes the southern Rideau Canal, 1000 Islands and Eastern Land 'O lakes (Craig, 2010). This area was recognized as a United Nations Educational, Scientific and Cultural Organization (UNESCO) world heritage site in November 2002 and was designated by UNESCO's "Man and the Biosphere Program," such that the reserve is connected to economic and social development groups, educational and conservation communities and is devoted to the development of a sustainable society (Frontenac Arch Biosphere Reserve, 2011). Biosphere reserves foster a positive atmosphere for the promotion of sustainable waste management research and improvements. Since waste is an innate part of human lifestyle, the aim of this project is to understand the lifecycle of waste within the FABR region, be able to summarize that information, and present new opportunities for waste management to the FABR Board. The report uses ArcGIS 10 maps and tables to convey information and looks at education and biogas as opportunities for diverting waste. Different types of waste could have been researched for our report including liquid waste from wastewater, sewage or gaseous wastes. However, this report focuses on municipal solid waste (MSW) and predominantly waste disposal sites, namely landfills, because of the data available, the FABR Board's

interest in having this compiled information and recent articles that state that MSW management issues have "moved to the fore of the public agenda, with levels of concern and activity by citizens and governments world-wide reaching unprecedented levels" (Read, 1997). Continuing today, "waste management is a very important issue, stemming from solid waste; Each person and each company needs to find their own ways to deal with it […] we are all responsible when it comes to making our planet safer and more environmentally friendly" (Noton, 2010). Thus, MSW is an important source of waste that should be reported on.

Our goal, as mentioned above for this report, follows accordingly with the *South Frontenac Township's* "Waste Recycling Strategy" which states:

> "Our long term goals are to increase the sustainability of our community, make our community a cleaner, greener place to live and enhance the service and value for our taxpayers […] reduce our impact on the local environment and transition to consistent recycling programs and policies throughout our service area" (2011)

Environmental indicators pertaining to FABR's municipal landfills will be examined to determine their impact on FABR's environment. Along with contributing to a state of the environment report, the collection of information pertaining to specific indicators will be presented to the FABR Board of Directors. The Board will hopefully support opportunities stemming from these indicators so actions can be made to improve waste management in the FABR.

6.2 Objectives

Within the report's goal of analyzing and suggesting improvement for current waste management practices with the FABR region, focusing on SFT and the TLTI, this report identifies the following objectives:

- Develop a comprehensive map of all MSW landfills within the FABR and assemble key characteristics on each
- Investigate waste management practices in SFT and the TLTI
- Investigate gaps in waste management policies and the success of any such policies in the past
- Identify areas of improvement based on current landfill characteristics
- Examine possible organic waste diversion to biogas facilities and its feasibility

6.3 Relationship to Sustainability

The Frontenac Arch Biosphere Reserve aims to be a model of sustainability. The UNESCO "Man and the Biosphere" program mandates that biosphere reserves serve the following three functions in order to fully implement sustainability into practice:

1. A conservation function – to contribute to the conservation of landscapes, ecosystems, species and genetic variation
2. A development function – to foster economic and human development, which is socioculturally and ecologically sustainable
3. A logistic function – to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development. (Dogse, 2004)

Growing populations, land use changes and an increased amount of industrial production make the concepts of waste management crucial into the implementation of sustainability into a community. This project will provide contributions to the future state of the environment report with regards to certain waste management practices in the FABR and how they are operating to fulfill the above three functions. It is important for waste management to be assessed in this way because, in the context of the biosphere reserve, sustainability is best met when these three areas are considered.

Specifically, this project examines the process by which MSW is managed through landfill sites within the FABR. Locating all existing landfill sites in the FABR region and collecting in-depth data on the landfill practices in the TLTI as well as the SFT provides a helpful overview of the state of the waste management system, as it relates to MSW. This research allows FABR Board members to have a visual understanding of the location of landfills and their characteristics through the creation of a GIS map and associated attribute table. Additionally, gathering information on specific landfill practices will allow for the long-term health of the landfill and surrounding environment to be understood; the conservation function, as referenced above. Opportunities that have arisen from this research support the diversion of organic waste from landfills to the production of energy through biogas utilization. Other opportunities include implementing successful waste management practices in the SF into the TLTI and vice versa. These new strategies contribute to the development function of implementing sustainability. Finally, by collecting raw data on the selected landfills and by creating a working GIS map of all the landfills within FABR, coupled with an associated attributes table, a foundation for additional research and monitoring of landfill practices in the FABR is established. Combined, this research will help the FABR to become a model of sustainability as it pertains to solid waste management.

7) Scope

The goal of this study was to compile a complete survey of the solid waste management practices in the FABR and apply these results across the entire biosphere. Furthermore, in-depth case studies of nine landfills spanning two townships (SFT and the TLTI) were carried out in order to determine the nature of current waste disposal practices. Such an approach allowed us to explore the life cycle of waste, both within the biosphere and in greater detail in the studied townships. From these data and results, opportunities for improved waste management practices in the FABR were examined, either through better waste management policies or new approaches to diverting wastes from landfills.

As mentioned above, the primary spatial boundaries of this report were within the entire FABR and, in more detail, SFT and the TLTI. The report looks at historical waste disposal data within the biosphere to provide context for current and future measurements. In addition, this report attempts to characterize (both quantitatively and qualitatively) the waste management practices within the entire FABR, and then to look at two representative case studies in order to better understand these practices.

Lastly, the scope was narrowed within "Waste Management" to deal with only solid wastes and predominantly waste disposal sites. These sites are representative of broader waste management policies in these jurisdictions and by understanding their functionality conclusions can be drawn on the broader state of waste management in the FABR.

8) Indicators

8.1 Broad Level and Case-specific Indicators

In order to measure the sustainability of waste and waste management in the FABR, this report will consider four indicators from which to draw its final conclusions and recommendations. As discussed in the scope, this study focuses on the life cycle of MSW going to landfills across the entire FABR as well as focusing in greater detail on the waste management practices in the SFT and the TLTI. As such, different representative indicators have been chosen to characterize both the broader scope and the two case studies.

The indicators are summarized in Table 1. In addition, as the indicators themselves can be considered wide in their own scope, this report has specified metrics for each indicator that can be directly measured or assessed in order to draw larger conclusions on the state of the indicator.

Broad Level Indicator	**Metrics Used for Analysis**
• Landfill Characteristics	• Accepted Materials • Lifespan
Case Specific Indicators	
• Landfill Characteristics	• Accepted Materials • Lifespan • Size • Traffic • Practices and Methods
• Strategic Waste Management Plan	• Local Policy • Funding • Participation • Collection Amount • Effectiveness
• Waste Technology	• Machinery • Bag Tags • Clear Bag Usage

Table 1. Summary of indicators and their respective metrics used.

As seen in Table 1, the sole indicator that has been assessed over the entire FABR region is the landfill characteristics of all open landfills within the region. This analysis has provided the location of all landfills within the biosphere as well as summaries of what they will accept and their other basic landfill practices. Within the SFT and the TLTI, these same landfill characteristics are also evaluated but, in addition, further data was collected on the size, traffic and detailed landfill practices. Moreover, in these two townships, the report has looked at their strategic waste management plans and their technologies in place to handle waste as indicators of their overall waste management practices. In order to evaluate these two indicators, the report has assessed quantitative and qualitative metrics that are aimed to accurately represent the state of the indicators.

It is hoped that by assessing these three indicators over two scales, the report will not only have a thorough understanding of current waste management practices within the FABR but, more importantly, will be able to present meaningful opportunities for improvement.

8.2 Indicator selection

The indicators were selected in order to be both complete but also manageable for this report to cover in significant detail. As noted by the Frontenac Arch Biosphere Board of Directors, there was a need for the quantification of all of the open landfills within the FABR. Initial research showed that this was an attainable goal; however, due to the large number of landfills across the biosphere and all of their subsequent data, it would be unfeasible for the report to consider them all in great depth. Instead of attempting to handle data for each landfill, it was decided that the report would focus on the landfills in two townships within the FABR. In this manner, detailed data from these two townships could then be reasonably extrapolated to their similar counterparts within the region, and valuable conclusions could be made. The townships of South Frontenac and Leeds and the Thousand Islands were chosen due to their high concentration of landfills within their jurisdictions. This was indicative of high production of MSW in these two areas in relation to other townships within the FABR. There are six active landfills in SFT and three active landfills in the TLTI. Furthering the interest, SFT has recently implemented a new Waste Recycling Strategy in April 2011 and the ENSC 430* class visited the Lansdowne landfill in the TLTI on a class field trip.

The three indicators themselves are aimed to be representative of the current life cycle of MSW within the FABR. The primary instruction for waste management within these communities comes from their own strategic waste management plans (*South Frontenac Waste Recycling Strategy*, 2011; Jarrett, Lolley, Smith and Walker, 2009). Such documents outline the practices that local residents must adhere to in order to properly dispose of their waste. From this point, the process is then turned over to waste technologies to properly handle the waste and present it in a form that can be placed into a landfill. Once at the landfill, waste is either incorporated or diverted to recycling programs (see Appendix 16.4.1.1).

This report's indicators attempt to characterize each stage of waste movement and then subsequently be able to draw recommendations for improvement in order to have the minimum amount of waste be directed in to a landfill.

9) Methods

9.1 Introduction

The methods revolved around the collection and synthesis of information concerning the selected indicators and researching opportunities to divert waste. Online resources and phone and e-mail interviews were used to collect data. An attribute table was made to summarize information on landfills and GIS maps were created in ArcGIS 10 to indicate the location and basic characteristics of all landfills in FABR. In addition, key statistics gathered on the SFT and the TLTI were organized into several tables in Excel, to allow for easy comparison and analysis of data between these two case studies. A workshop was also held to obtain feedback on this project from the ENSC 430* class.

9.2 Resources

9.2.1 Data Collection

Data for our indicators was collected using several online tools such as township websites, Statistics Canada, and government documents. Queen's staff members Morag Coyne, Susan Greaves and Jeff Moon were valuable resources in demonstrating how to collect online data for our project.

In addition, phone and e-mail interviews were conducted to verify information, obtain information not available online, and acquire opinions with regards to this report's opportunities to divert waste. Contacts for interviews were found using Township Websites and through FABR Board of Director members. A general set of questions was formulated to ensure some consistency in the interviewing process and to aid in ensuring our project is reproducible in the future (see Appendix 16.1). These questions were directed towards township workers responsible in some capacity for landfills, in particular in the SFT and the TLTI, where landfills were examined in greater detail. Overall approximately twenty township representatives were briefly contacted to verify and obtain basic landfill information, and three in depth interviews were conducted with SFT and TLTI waste management representatives.

9.2.2 Group workshop

A workshop was held in class on October 24, 2011 during which the project was presented to the ENSC 430* class to obtain constructive feedback. At the beginning of the workshop questionnaires were handed out to engage the class in thought about waste management (see Appendix 16.2). A ten-minute presentation followed, and then two breakout sessions were held. In the first breakout session, groups responded to questions posed about waste management with respect to their group topic. In the

second breakout session, groups acted as different stakeholders responding to the implementation of biogas facilities into theoretical townships (see Appendix 16.2). These exercises provided useful feedback and were helpful in further conceptualizing the project.

9.3 Attribute Table, Key Statistics Table and GIS Map

Landfill information gathered through data collection was then compiled and summarized into an attribute table in Microsoft Excel (see Figures 1, 2 and Appendix 16.4.1.2). This table builds off of the one created in 2009 by the ENSC 430* Waste & Energy group and it includes all of the landfills in the FABR.

Furthermore, multiple tables were created in Microsoft Excel (see Tables 2-5 and Appendix 16.4.2) that summarize and highlight key statistics on the SFT and the TLTI. These statistics include township population, annual waste produced, and annual percentage of waste recycled. The statistics were gathered from the townships' waste management strategies and plans. In addition to providing important background information on the two townships, these created tables permit comparison of the township's annual waste production and recycling.

The ArcGIS maps were created with the assistance of Queen's librarians and ENSC 430* professors and TAs. The landfill UTM coordinates were collected using Google Maps and Google Earth based on the landfill addresses found on government websites and confirmed by township representatives; if no specific address could be found then the landfill was located on Google Earth and the UTM coordinates were taken accordingly.

9.4 Biogas Research

Research on biogas facilities, as an opportunity for waste diversion, was conducted using a variety of methods. Firstly, a case study conducted by the BioProducts Association on organic waste diversion through biogas utilization on Fraser Valley in British Columbia was examined. Additionally, Ledgecroft farms was used as a case study for the implementation of biogas facilities in the FABR and, along with waste management township representatives from SFT and TLTI, the feasibility of diverting organic waste to biogas sites was gauged. Data on the number of dairy farms in FABR was found using Statistics Canada, and the ENSC 430* 2010 Energy report provided useful background information on biogas facilities.

10) Results

10.1 Group Workshop

The workshop held in ENSC 430* provided useful feedback on this project. The first breakout session brought different perspectives on waste management to the forefront. Both the Climate Change group and the Biodiversity group cited introducing effective composting programs of a means of improving the waste management in the FABR. Notably, the Biodiversity group also suggested tackling waste management issues at the source, by focusing on education of the public to increase recycling and decrease the waste produced in townships. Other groups also discussed increasing public awareness of waste management to be more sustainable and the Society and Culture group suggested a recycled art exhibit be created to encourage recycling. This feedback was taken into account when making recommendations to improve waste diversion in the FABR.

The second break out session, which focused on the views of different stakeholders that would be involved in township biogas implementation, helped identify prominent concerns and obstacles to this opportunity. For instance, when asked what hurdles there were for implementing biogas facilities all of the groups responded with funding/cost, amongst others. Research on funding/cost was therefore highlighted as an important component to explore when examining biogas as an opportunity.

Although the group workshop was important in aiding this study's development, the primary interpretations and analysis stemmed from the following results.

10.2 Symposium

On November 21, 2011, an Environmental Studies Honors Project Symposium was held in which all the ENSC 430* groups presented the information gathered thus far. The waste management presentation facilitated discussions between members of the FABR Board, professors, ENSC 430* peers and invited township guests. Information regarding Bullfrog was discussed. Bullfrog Power is a company that provides 100% renewable electricity to citizens of British Columbia, Alberta, Ontario and the Maritimes. Since energy use is the largest contributor to a person's ecological footprint, Bullfrog Power is devoted to giving people a sustainable energy option (*Bullfrog Power,* 2011). Starting in 2011, Bullfrog Power has started to accept renewable energy in the form of biogas but currently only collects energy from on landfill located in Quebec (Interview). Thus, Bullfrog Power may want to be looked at in the future as a means of buying biogas energy. Furthermore, the economics of curbside pick-up was discussed with a representative from TLTI. The representative noted that many residents are against

having curbside pickup because they see it linked with increased taxes; however, he said that the decreased need for landfill workers would decrease taxes. Consequently, implementing curbside pick-up would not increase taxes by much, if at all. Moreover, the TLTI representative had been searching for a means of hay-bail plastic collection in TLTI, as will be implemented in South Frontenac. Therefore, the representative was put in touch with a SFT representative who could provide more information on this topic. Hay-bail plastic collection will be discussed further in the Opportunities section.

10.3 Attribute Table

The attribute table displayed partly in Figures 1 and 2, and fully in Appendix 16.4.1.2, summarizes basic information collected on all the landfills in and around the FABR, in accordance with the report's broad level indicator. The attribute table answers questions like what recyclables, hazardous waste, electronic waste, and organics are collected at the landfill; additionally the table shows whether the landfill requires bag tags or clear bags, if is it open, if it facilitates curbside pick-up and what its lifespan is.

	Waste Collection	Transparent bags?	Bag Tags?	Lifespan	Recyclables accepted	E-waste?	Compost?	Hazardous waste?	Outside of FABR boundary?
Bradshaw waste disposal	curbside pickup, garbage and recycling and landfill drop-off	no	yes	23 years	plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site	no *e-waste depot within South Frotenac	no	no *hazardous waste facility implemented june 2011, within SF	no
Geen Bay dump site	curbside pickup, garbage and recycling and landfill drop-off	no	yes	20 years	same	no	no	no *hazardous waste facility implemented june 2011, within SF	no
Massassauga Dump site	curbside pickup, garbage and recycling and landfill drop-off	no	yes	1 year	same	no	no	no *hazardous waste facility implemented june 2011, within SF	no
Salem waste disposal	curbside pickup, garbage and recycling and landfill drop-off	no	yes	14 years	same	no	no	no *hazardous waste facility implemented june 2011, within SF	yes
Loughborough waste disposal site	curbside pickup, garbage and recycling and landfill drop-off	no	yes	12 years	same	no	no	no *hazardous waste facility implemented june 2011, within SF	yes
Portland waste disposal site	curbside pickup, garbage and recycling and landfill drop-off	no	yes	32 years	same	no	no	no *hazardous waste facility implemented june 2011, within SF	yes

Figure 1. Attribute Table for the South Frontenac Township

	Waste Collection	Transparent bags?	Bag Tags?	Lifespan	Recyclables accepted	E-waste?	Compost?	Hazardous waste?	Outside of FABR boundary?
Lansdowne waste site	Landsdowne residents have curbside collection of garbage and recyclables.	yes	yes, $1.50 each	8.5 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	yes	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	no
Lyndhurst waste site	Landfill drop off. Max. 40 pounds	yes	yes, $1.50 each	10 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	yes	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	no
Escott waste site	Landfill drop off. Max. 40 pounds	yes	yes, $1.50 each	11.5 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	no	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	no

Figure 2. Attribute Table for the Township of Leeds and the Thousand Islands

10.4 ArcGIS 10 Maps

The second step for the data collection is to organize the information from the attribute table into ArcGIS 10 maps, two of which are displayed in Figure 3 and Figure 4. Additional maps displaying this information can be seen in Figure 7 and Appendix 16.4.3. The data embedded in the GIS maps contain all of the landfills located within and around the FABR. There is an embedded attribute table with all the information from the original attribute table stored in GIS (see figure 4).

Furthermore, these maps include the roads and major towns all clipped to the FABR boundary, which can be manipulated to show various data sets, depending how the query builder is used.

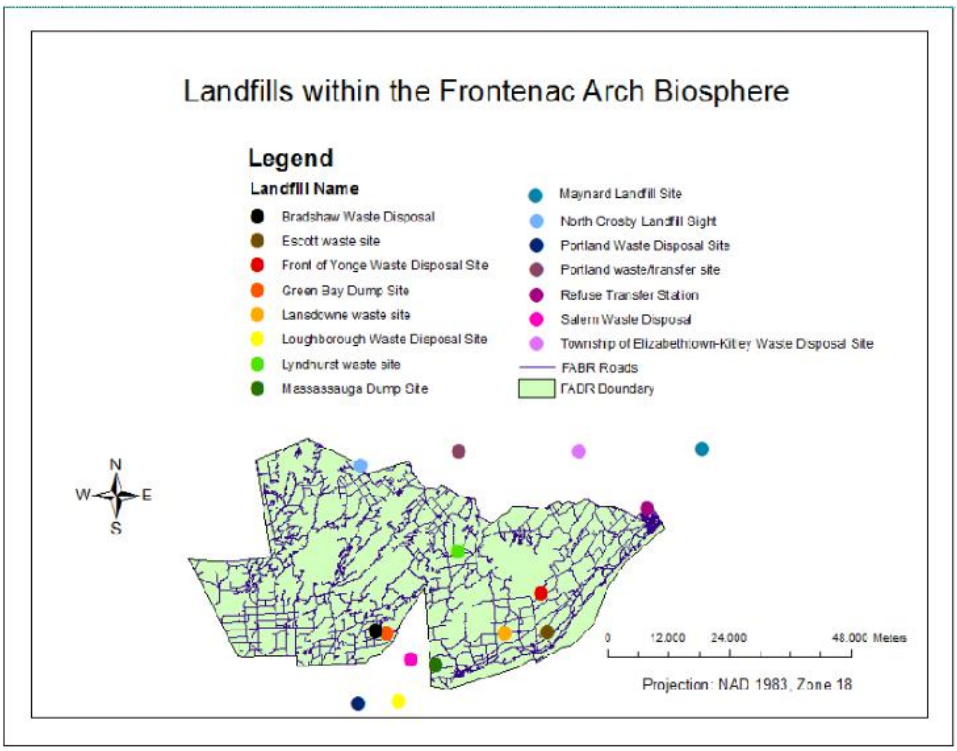

Figure 3. ArcGIS Landfill Map

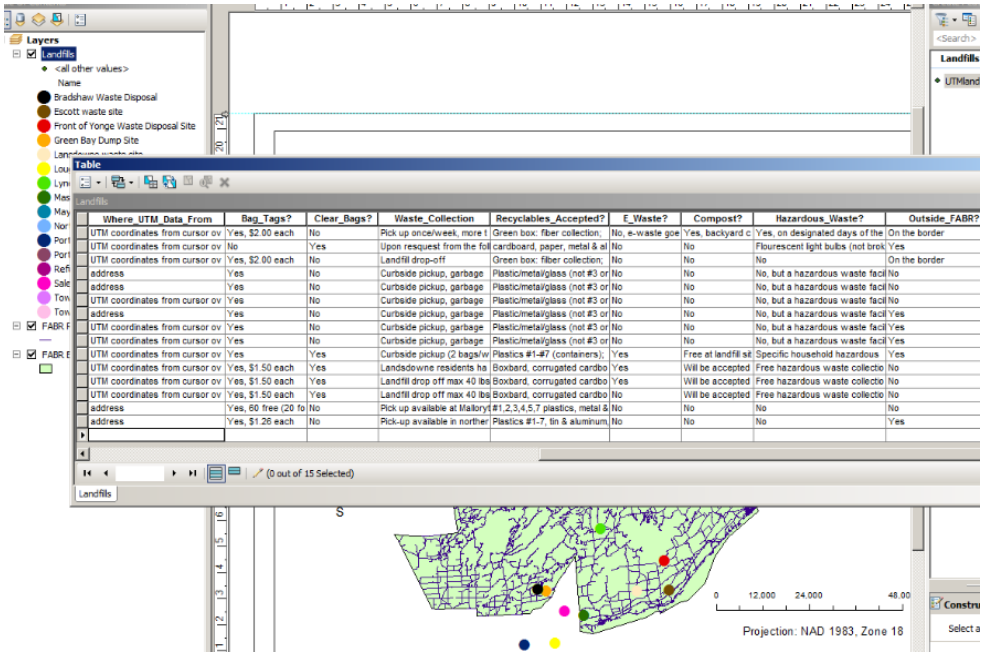

Figure 4. Attribute Table Embedded in ArcGIS Map

10.5 Case-Specific Results

In order to provide an in depth comparison of the landfill practices between the SFT and the TLTI, any and all data pertaining to the nine landfills in question was collected. The following tables represent the data that was available through the public works departments of each township. Although the data available differs between townships, a key statistics table is also presented which outlines directly comparable statistics.

Site Statistics	Loughborough	Bradshaw	Portland	Green Bay	Mass	Salem
Total Site Area	26.61 ha	6.6 ha	31.4 ha	2.3 ha	4.37 ha	9.98 ha
Approved Area of Waste Disposal	2.90 ha	0.48 ha	20.0 ha	0.6 ha	0.4 ha	0.8 ha
Current Area of Waste Disposal	1.93 ha	0.45 ha	3.3 ha	0.22 ha	0.26 ha	0.6 ha
Total Capacity Including Final Cover	231 250 m^3	14 500 m^3	422 100 m^3	14 500 m^3	14 060 m^3	65 000 m^3
Allowance for Final Cover	21 750 m^3	3 600 m^3	42 000 m^3	4 500 m^3	3 000 m^3	6 000 m^3
Total Capacity	209 500 m^3	16 200 m^3	380 100 m^3	10 000 m^3	11 060 m^3	59 000 m^3
Existing Waste and Periodic Cover	137 920 m^3	8 750 m^3	180 500 m^3	5 110 m^3	10 640 m^3	43 410 m^3
Remaining Volume of Waste Disposal	71 580 m^3	7 480 m^3	199 600 m^3	4 890 m^3	420 m^3	16 590 m^3
Remaining Lifespan	12	23	32	20	1	14
Closure Date	2022	2033	2042	2030	2011	2024
Estimates Closure Costs	$280 000	$100 000	$1 100 000	$100 000	$90 000	$160 000
Estimated Monitoring Costs	$14 000	$8 000	$14 000	$8 000	$8 000	$8 000

Table 2. Site statistics of all landfills in operation within the South Frontenac Township. Data was collected from the SFT 2010 Annual Report to Council, 2011.

Waste Quantities	Loughborough	Portland	South Frontenac
Measured Usage for 2010 (m^3)	3 220	4 580	11 970
Measured Waste Generation Rate (kg/cap/day)	0.7	1.09	0.67
% of Predicted Usage (%)	58%	87%	67%
Average Usage (m^3)	4 350	5 860	13 980
Average Waste Generation Rate (kg/cap/day)	0.94	1.39	0.79
% of Predicted Usage (%)	79%	112%	79%
Predicted Usage (m^3)	5 526	5 251	17 798
Predicted Waste Generation Rate (kg/cap/day)	1.2	1.25	1
Blue Box Recycling (tonne)	297	254	933

Table 3. Waste quantities of selected landfills in operation within the South Frontenac Township (SFT) as well as the SFT as a whole in 2010. Data was collected from the SFT 2010 Annual Report to Council, 2011.

	Lansdowne Landfill:
Types of Waste Recycled (kg)	
Organics	112, 920
Paper	37, 791
Other	30, 023
Plastic	29, 651
Glass	27, 446
Textile	15, 084
Metal	6, 581
Wood	2, 184
Grand Total	261, 680
Total Recycling (kg)	270, 394 (299 tonnes)
MSW Space Taken Up (cubic meters of space/year)	3,278
Approximate Waste Produced/ year	3, 477 tonnes
Total Amount Recycled	1838 tonnes
Total Amount Landfilled	1639 tonnes
Bags Disposed of at Lansdowne/ year	123, 994
Residual Waste/ year	1240 tonnes

Table 4. Landfill statistics of the Lansdowne landfill within the Township of Leeds and the Thousand Islands in 2009. The data was collected from the "Green Audit", which was conducted in 2009 within this township.

	Leeds and the Thousand Islands	South Frontenac
Approximate Population	9,600	18,000 (30,000 in summer)
Homes	5,306	10,000
Approximate Waste Produced/Year (tonnes)	3,477	5,000
Total Amount Landfilled (tonnes)	1,639	4,000
Total Amount Recycled (tonnes)	1,838	1,000
Percentage of Waste Recycled	53%	20%
Average Usage of Landfills/year (m^3)	3,278	11,970

Table 5. Key MSW statistics of the South Frontenac Township and the Township of Leeds and the Thousand Islands (Jarrett et al., 2009; *South Frontenac Waste Recycling Strategy*, 2011).

11) Critical Comparison of South Frontenac and Leeds and the Thousand Islands

A fundamental component of the study included narrowing the scope of research to exclusively compare two townships within the FABR: the South Frontenac Township and the Township of Leeds and the Thousand Islands. The most recent version of each township's waste management strategy was collected, as well as any existing information and/or data pertaining to the specific landfills currently in operation within these two townships. This information was used to directly provide evidence as well as current status of the case specific indicators, as listed in Table 1. With this information many significant comparisons surfaced (*South Frontenac Waste Recycling Strategy*, 2011; Jarrett et al., 2009).

Both SFT and TLTI had several open landfills that were directly implemented into their respective waste management strategies. Through examining these strategies it was found that the lifecycle of MSW, in these townships, was directly affected by the health and specific operation of each of the landfills. Therefore, it was necessary throughout this comparison to consider each component of the provided waste management strategies and accompanying landfill data, and how they might affect

the health of the landfills, or in contrast, how the status of the landfills might affect the health and integrity of the components listed in the waste management strategy.

To provide an overarching perspective, showing the comparison between SFT and TLTI in terms of waste production and diversion, a table of key statistics was formulated (Table 5). Key data to consider for SFT included: the population of ~ 18,000, the annual waste production of ~5000 tonnes and the annual percentage of waste diverted, which was 20%. Similarly, key data to consider for TLTI included: the population of ~ 9, 600, the annual waste production of ~ 3, 477 tonnes and the annual percentage of waste diverted, which was 53%. Examining the total diversion rates of each township was important in understanding how the practices at each landfill affected this metric. Furthermore, the practices and operations at each landfill were indicative of the types of waste management practices outlined in each townships waste management strategy. Differences in the waste management strategies of SFT and TLTI yielded a difference in landfill characteristics and practices, which might have contributed to the inconsistency between the annual waste diversion rates between the two townships.

In the SFT, the primary source of waste diversion is conducted through the Blue Box recycling program. This program was enforced through a recycling by-law (By-Law 2005-98) (*South Frontenac Waste Recycling Strategy*, 2011). Through this program, the residents of South Frontenac are provided the service of having their recyclables picked up each week at their curb. These recyclables are delivered to the Bradshaw and Salem Landfill Sites and finally processed at the Kingston MRF (KARC). The Bradshaw and Salem Landfill Sites, therefore, act as a transfer site and not a housing facility for the recyclables collected through the Blue Box program. In terms of non-recyclable waste, curbside pick-up is provided weekly for the SFT residents, provided that all bags disposed of have a bag tag attached.

In terms of the physical landfill sites, implementation of diversion methods was minimal in the SFT. The six landfill sites in this township did not have adequate separation bins for recyclables, compost and/or organic waste (*South Frontenac Waste Recycling Strategy*, 2011). The separation bins necessary for these types of waste were not existent at these landfills or were poorly maintained, and therefore ineffective (*South Frontenac Waste Recycling Strategy*, 2011). Electronic Waste (e-waste) however, was accepted, and properly separated from residual waste, at the Portland, Loughborough and Salem Landfill sites. Hazardous waste was also accepted at a separate and distinct hazardous waste transfer site. The e-waste facilities were available on a daily basis, while the hazardous waste transfer site was available on a weekly basis between the months of April to October ("South Frontenac: Garbage & Recycling Information," 2011).

Interestingly, the SFT diverted 20% of their MSW through the Blue Box program, while the immediate potential of this diversion rate was 48%, as can be seen in Table 6. With the provincial standard for waste diversion being 60%, SFT's yield was inadequate (Jarrett et al., 2009). Furthermore, there was most likely a discrepancy present in the Blue Box system, as the total percent of recyclables available in this township was 48%, while only 20% became diverted through recycling. The SFT's goal, as indicated in their 2011 *Waste Management Report*, is to reach a waste management rate of 48%/year.

Residential Solid Waste Generated and Diverted through Blue Box		
Residential Waste Stream/Blue Box Material (WDO comparable municipality estimates)	**Tonnes**	**Percent of Total Waste**
Total waste generated	5000	-
Non blue box waste	2600	52%
Total Recyclables Available	2400	48%
Papers (ONP, OMG, OCC, OBB and fine papers)	1500	30%
Metals (aluminum, steel, mixed metal)	150	3%
Plastics (containers, film, tubs and lids)	350	7%
Glass	400	8%
Total Blue Box material currently diverted	1000	20%

Table 6. The amount of waste that is diverted through the Blue Box program in the South Frontenac Township (*South Frontenac Waste Recycling Strategy*, 2011).

The TLTI took a significantly different approach to waste diversion management. In this township, waste diversion mostly occurred at one of the three landfills currently in operation, in contrast to curbside pick-up. As a result, the primary source of waste diversion was conducted through the maintenance of separation bins at each of these landfills. The degree of separation, specifically at Ward 1 (Lansdowne Landfill) allowed for a multitude of waste to be diverted efficiently. As such, the Lansdowne Landfill accepted and separated: cardboard, plastics, metals and aluminum, glass, paper and, as of recent, organics/compost. These separation bins, although present at the Lyndhurst and Escott Landfill (Ward 2 & 3) site, were not as effective due to the fact that these sites lacked the "delivery station", a station allowing for easy waste disposal and separation; this component is present at the Lansdowne Landfill (Jarrett et al., 2009). It was reported that the lack of a user-friendly system, pertaining to the drop-off of waste at the landfills, resulted in the Lyndhurst and Escott landfills being: "environmentally wasteful", "inconvenient", "unpleasant" and "not encouraging of good waste management practices" (Jarrett et al., 2009). As seen in Table 7, there is a significant difference in the

quantities of separated recyclables disposed of at the Lansdowne Landfill compared to that of the Escott and Lyndhurst landfills (Jarrett et al., 2009).

	Landfill Site		
Material	**Briar Hill**	**Escott**	**Lansdowne**
Comingled	35 mt	20 mt	92 mt
Metal	48 mt	20 mt	119 mt
Cardboard	37 mt	13 mt	87 mt
Newspaper / mixed	63 mt	30 mt	134 mt

Table 7. Quantity of recyclables collected at individual landfills within the Township of Leeds and the Thousand Islands in 2010. Table was obtained from the Public Works Tender 2011-008: Collection & Processing of Recyclables proposal. Note: the Lyndhurst Landfill can also be referred to as the Briar Hill Landfill.

The TLTI indicated that they would like to initiate township-wide curbside pick-up for recycling, compost and residual waste as a source for heightened diversion, in their waste management report. However, at the time of this study, curbside pick-up for recycling and residual waste was only available for residents living in the Lansdowne area. The recycling collected from this program was disposed of and separated at the Lansdowne Landfill. At the time of this study, the TLTI was in the process of contracting the processing stage of recycling to an external source that would ultimately remove the recycled waste from the landfills to a Municipal Recycling Facility (Jarrett et al., 2009). Arguably, this would allow for an increased number of items to be recycled and for a subsequent decrease in the amount of waste going into the landfill (Jarrett et al., 2009).

During the "Green Squad Waste Audit", conducted at the Lansdowne Landfill in 2009, it was reported that 43.2% of the residual waste entering the landfill, and therefore exempt from the recycling process, was organic in nature (Jarrett et al., 2009). Accordingly, the township introduced an organic/compost waste disposal system at each of the three landfills in November of 2011. The township had a goal of increasing their diversion rate from the current 53% to 60% by 2014. This will most likely be attainable due to the diversion strategies that were put in place, such as a compost/organic waste disposal site.

The significant difference in diversion rates between the discussed townships (SF having a 20%/year diversion rate and TLTI having a 53%/year diversion rate) is most likely indicative of the success and reliability of each township's waste management strategy.

There were important differences in the waste management strategies of SF and TLTI that were considered in order to understand the causes of the above findings. Specifically, the potential benefits of curbside pick-up versus landfill drop-off were examined. As stated previously, SFT offered the service of township-wide curbside pick-up. This included weekly collection of the resident's recyclables and residual waste. This program allowed for a limitless number of garbage bags to be placed at the curb for pick-up each week, provided they were labeled with a bag tag; bag tags cost $2.00/tag available at local vendors. The theory behind attaching a tariff to waste placed at the curb, through the implementation of bag tags, was supposed to encourage waste reduction through recycling and re-using. When compared to the waste generation of TLTI, this theory seemed to hold true. Referring to Table 5, the data showed that, at the respective times of data collection, SFT produced 9% less residual waste, destined for local landfills, than did TLTI, proportionally. This result could be attributed to the potential benefits of curbside pick-up, coupled with the tariff imposed on producing bags of waste for disposal. A setback to the curbside pick-up program (Blue Box pick-up and residual waste pick-up) in SFT, which was highlighted in the *Waste Recycling Strategy*, was the presence of seasonal residents in this township. Each year, SFT estimated that approximately 12,000 seasonal residents inhabited the SFT for the summer months (*South Frontenac Waste Recycling Strategy*, 2011). These residents typically lived down private roads, making pick-up quite challenging for the municipality; and additionally, education about the waste management process is quite limited amongst these residents due to the nature of seasonal residency (*South Frontenac Waste Recycling Strategy*, 2011). The factor of seasonal residency could have depressed their potential for an even lesser percent of waste produced compared to TLTI, proportionally.

In contrast, during the time of research, TLTI did not offer curbside pick-up to their residents living in Ward 2 & 3, however this service was available for residents in Ward 1. The *Waste Management Committee Report* outlined the desire to introduce township-wide curbside pick-up with accompanied recycling pick-up (as well as future compost pick-up through the Green Bin Program), as they recommended this would increase waste diversion and allow for the Ward 2 & 3 landfills to be closed. Controversy that surrounded this initiative included the fear that a curbside pick-up program might cause a deterioration of the resident's knowledge and responsibility for their household waste management practices. Having to organize and separate one's own waste, and dispose of it at a landfill, allowed for the residents of TLTI to be directly involved and responsible for the lifecycle of their waste. These understandings set their limits at the curb when residents, instead, dispose of their waste through

curbside pick-up. The practice of landfill drop-off in TLTI, may have contributed to the 53% waste diversion rate that TLTI accomplished, which was 33% higher than that of SFT in comparison.

Another component considered when weighing the potential benefits of curbside pick-up, was cost-analysis. When residents were expected to drop off their waste at the nearest landfill, the costs of fuel and any vehicles required to deliver their waste were paid on an individual basis depending on the amount of waste one may have. It is possible, especially in rural areas similar to the FABR, that some residents may have to travel significantly larger distances than others based on local landfill distribution. When considering implementing curbside pickup, evidently the township incurs a cost to hire a contractor for curbside waste collection and this cost is subsequently passed on to the local taxpayers. The residents are no longer responsible for the cost of taking their waste to the landfill but they must then all contribute through taxes to standardized waste collection.

In performing the cost-benefit analysis of implementing curbside pick across the township, James Lolley, Chair of the Leeds and the Thousand Islands Waste Management Committee, indicated to the report that his proposal has been met with some backlash from residents who do not want to see a rise in their taxes. While Mr. Lolley understood their economic concerns, he also noted that with curbside pickup, the TLTI would be able to reduce the costs of managing their three landfills and thereby provide tax relief to the residents to offset the increased cost of hiring a collection contractor. If waste was collected at the curb, Mr. Lolley argued that the township could fill their three landfills sequentially and only incur the operating costs of having one open at any given time. As residents would no longer be dropping off their MSW, multiple landfills would not have to remain open for geographical convenience to the entire township. In Leeds and the Thousand Islands, the Lansdowne waste disposal site has the greatest opportunity to be expanded and, as such, Mr. Lolley advocated that with curbside pickup, the Lyndhurst and Escott waste disposal sites could be filled and closed, leaving the Lansdowne site as the township's sole landfill in the future. Mr. Lolley understood that these savings would be harder to conceptualize for residents as compared to a tax increase for curbside pickup, but he indicated that they were being considered in the township's future analysis.

From this analysis, there seemed to be many factors that influenced the benefits of curbside pick-up versus landfill drop-off, in comparing the practices of SFT and TLTI. Curbside pick-up allowed for efficiency in the collection of household waste production through the use of bag-tags and the Blue Bin program, while landfill drop-off allowed for consumer responsibility of waste and waste diversion. Despite the value that each practice holds for the residents of SFT and TLTI, it was important to examine

the impact of such on the health of the landfills themselves. Furthermore, aside from a focus on how the waste itself was being collected and disposed of in the landfills, it was important to identify the types of technology in place at these sites that controlled the incoming waste, as they related to either curbside pick-up or landfill drop-off.

The landfill technology present at the six waste disposal sites in the SFT was quite minimal. The technology that was present solely included the requirement of bag tags on each bag of waste entering the landfill. An interview was conducted with a representative from the SFT municipal office, to better understand the types of technology present at the each of the six landfills, which would ensure health and sustainability. This representative confirmed that the landfills within the municipality were lacking the appropriate technologies. Each of the six landfills did not have appropriate separation bins, as previously stated, which rendered a low waste diversion rate and subsequently might have caused landfills to reach their maximum potential at a greater pace. The representative also pointed out that the covering of landfills occurred on an inconsistent basis, if at all, at some of the smaller landfills. The consistent covering of waste entering the landfills is necessary in order to prevent harm done to the immediate environmental surrounding of the landfill; it also allows the landfill to acquire more space, as covering also conveniently aids in compacting the waste (Jarrett et al., 2009). Similarly, the interviewee verified that clear bags, shredders, compactors and weight scales were also not present at any of the six landfills within SFT. The representative acknowledged that these technologies were necessary in order to control the volume of waste entering the landfills, especially due to the nature of curbside pick-up. However, these necessities were not economically feasible for the SFT due to the sheer number of landfills that would require these investments. The representative expressed a desire to close many of the poorly equipped landfills in order to invest in three, or less, well equipped and efficiently operated landfills. Accordingly, this plan would be economically feasible and would improve the state of the SFT's waste management strategy.

The TLTI, landfills housed slightly improved landfill technologies compared to that of the SFT. Their *Waste Management Committee Report* also outlined plans that would actively improve these technologies in the near future, to exceed what currently exists (2009). At the time of research, the three landfills in the TLTI had compacting machinery, separation bins, compost/organic waste bins, a clear bag policy, required bag tags and had an easy and efficient "delivery station" (present at Ward 1 only), (see Appendix 16.4.2). These types of technologies were necessary given the nature of landfill drop-off. However, the *Waste Management Committee Report* indicated that there was still room for

improvement. Although the waste entering the landfills was spread and compacted upon a regular basis, research shows that the most effective compaction will result when the material being compacted is ~0.7m thick initially and is subjected to at least two and up to five passes of the compactor; TLTI did not possess compactor technologies of this caliber (Jarrett et al., 2009). Furthermore, the TLTI indicated a desire to invest in a shredder, which would reduce the size of material entering the landfill, allowing for compaction to become more effective. Clear bags, which in theory were supposed to prevent divertible waste from entering the landfill, had been somewhat ineffective in practice. In the *Waste Management Committee Report* it was noted, "every time a committee member visits the landfills, they had observed that considerable amounts of recyclable material are still going into the landfill", rendering the initiative slightly ineffective, and also deterring from the TLTI 60% diversion goal. Similar to the SFT, the TLTI has expressed a desire to reduce the number of landfills in operation by closing Ward 2 & 3, which would allow for increased investment into the Ward 1 landfill. They felt that having one landfill would allow more efficient technologies to be in effect, such as a shredder, weight scale and compactor. They also asserted that having one landfill would allow for better control of management of personnel in charge of operating the landfill. This would potentially reduce the amount of divertible waste entering the landfill. With having just one landfill, the disposal of waste for residents living a further distance from the landfill was problematic for the waste committee. As a result, the Committee recommends implementing township-wide curbside pick-up if the Ward 2 & Ward 3 landfills are to be closed.

In comparing several factors of each township's waste management strategies and how each of these affected the health of their respective landfills, it was evident that the SFT was lacking. Although, proportionally, this township managed to produce less waste than TLTI, their waste management strategy was not supportive of improved diversion plans, as seen in the TLTI. The TLTI had been actively implementing, specifically, organic waste methods at each of their landfills, whereas the SFT did not acknowledge the need for this type of diversion in their strategies. Furthermore, the technology present at each of the TLTI landfills had rendered more sustainable sites than those of the SFT, at which technology was essentially absent. These findings support a conclusion that the 53% diversion rate accomplished by the TLTI most likely occurred as a result of their active concern for waste diversion and subsequent implementation of this concern at the landfill site, rather than at the curb.

Both townships, through their waste management strategies, acknowledged a need for better data collection concerning their landfill sites. Many of the recommendations established within their strategies were hindered by the lack of data concerning the weight, tonnage and traffic at each of the

landfills (Jarrett et al., 2009; *South Frontenac Waste Recycling Strategy*, 2011). This barrier could be reconciled through the installation of weights and scales at the landfills, however economic feasibility was an issue given the number of landfills that were in operation within each township.

12) Opportunities

12.1 Landfills Attributes

12.1.1 Introduction

The GIS Map and attribute table provide awareness concerning the present waste sites in FABR by demonstrating their location and providing information on their characteristics (see Appendix 16.3 for summary brochure). The results from the characteristics researched about the landfills segue into a comparison of having many, small landfills versus few, large landfills. This issue will be discussed in detail below.

12.1.2 Attribute Table

The attribute table facilitates easy viewing and comparison of landfill information in and across townships, and can easily be modified and updated as landfill characteristics change. As a result, future ENSC 430* groups can modify the table so that it remains a reliable source of information on landfills and waste management practices and facilities in the FABR. In addition, the FABR could use the table to generate awareness amongst the townships about the different waste management practices in effect in the area, and to help pinpoint areas that need improvement (for instance, if a township lacks electronic waste disposal). This will be discussed further in Recommendations.

12.1.3 GIS Map

As discussed in the results section, the maps made in ArcGIS 10 will give the FABR Board an overview of the landfills and their accompanying characteristics. The base map for this document includes roads and major cities, which gives the landfills a point of reference within the FABR boundary. Since ArcGIS is a complex program, the hope is that representatives from the FABR Board will be able to use this document as a resource and future ENSC 430* groups will have the ArcGIS maps to build from. Since no maps had previously been made displaying the landfills inside and around the FABR limits, these maps are a valuable way of quickly showing viewers the scope of the project and how the landfills are coordinated within the different townships (Figure 5).

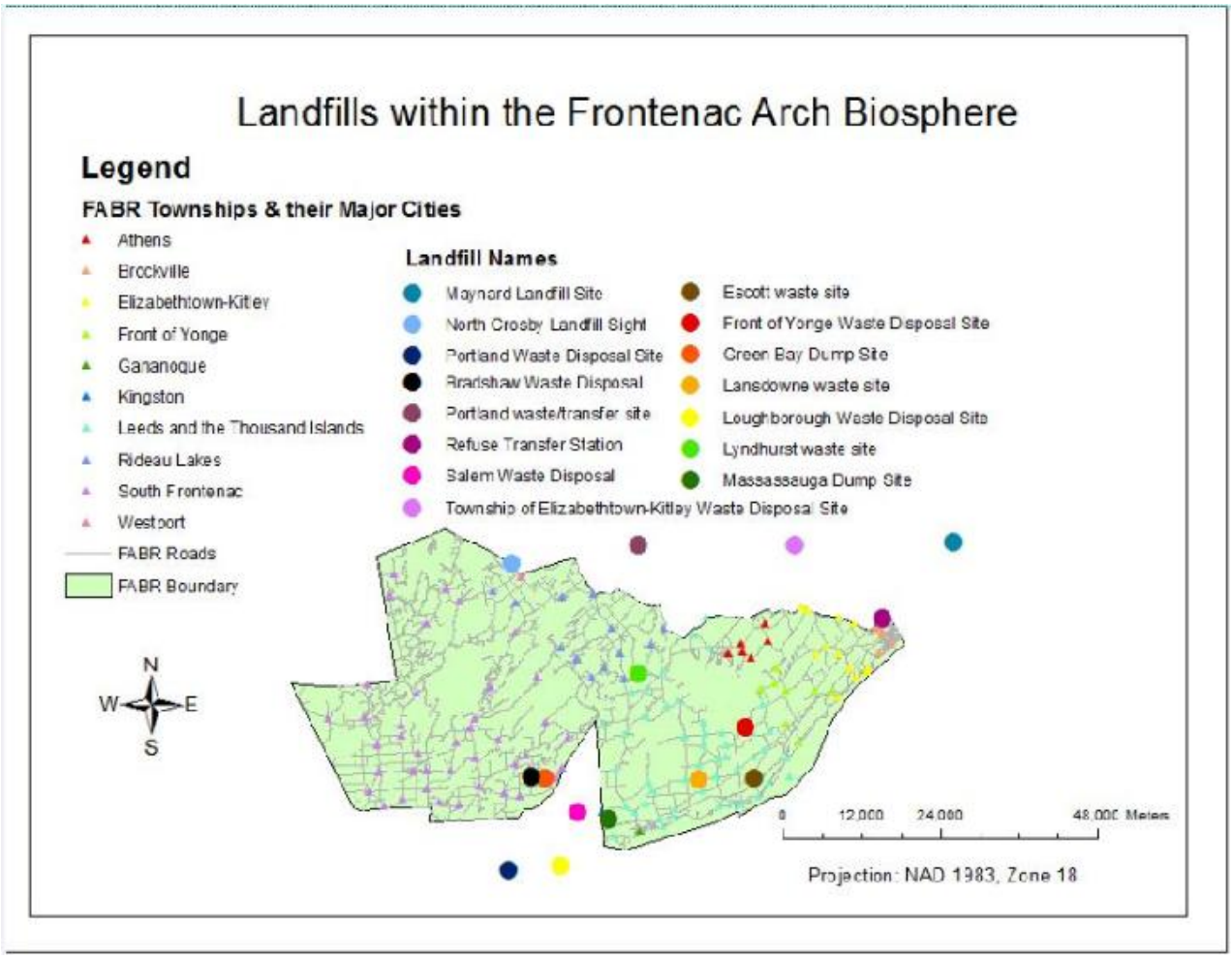

Figure 5. Landfills and Associated Major Cities in and around FABR

12.1.4 Comparison of Large and Small Landfills

For SFT and TLTI, there is the issue of having one large landfill versus having many small landfills. As discussed earlier, TLTI is aiming towards one large landfill at the Lansdowne site. In contrast, the SFT has not considered moving towards one large landfill yet but may do so in the future. After talking with representatives from both townships, there are important points to consider in both of these options:

Firstly, a large landfill allows the township to focus its attention and resources solely on it. Data collection could be improved if, for example, a weighing machine was implemented at the site. Data is incredibly important in the waste-management industry and unfortunately as a whole the FABR does not have very sufficient data records. Representatives from both SFT and TLTI both agreed that data collection is severely lacking within their townships. For SFT, none of the waste is weighed in at the landfills so all of the measurements are based on change in waste contours at the landfill sites. As a result, the data accumulation is very rough and extrapolated for the yearly intake. Consequently, South Frontenac's waste graph is not very exact (Figure 6).

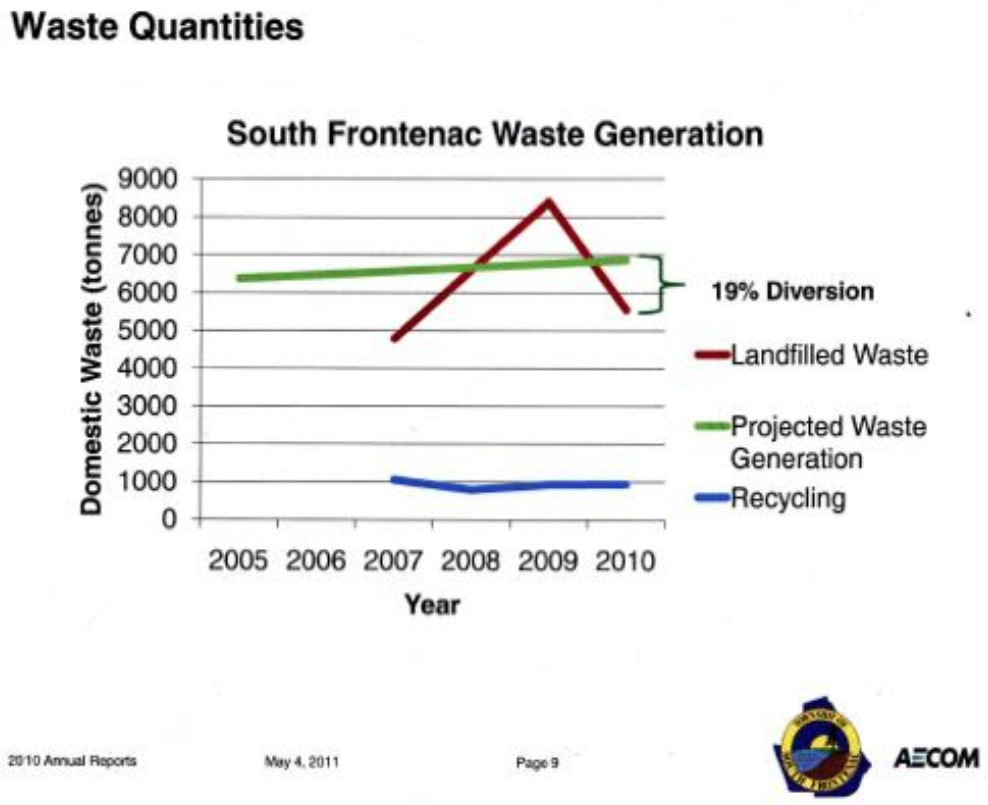

Figure 6. South Frontenac Waste Generation Graph 2005-2010 (Laporte, 2011).

In TLTI, a Waste Audit was performed in May 2009, although it was only conducted over a period of three days, solely at the Lansdowne Waste Site. The graph displayed in Figure 7 shows the

data from this waste audit which is much more informative, yet limited by its short collection period, than the South Frontenac data.

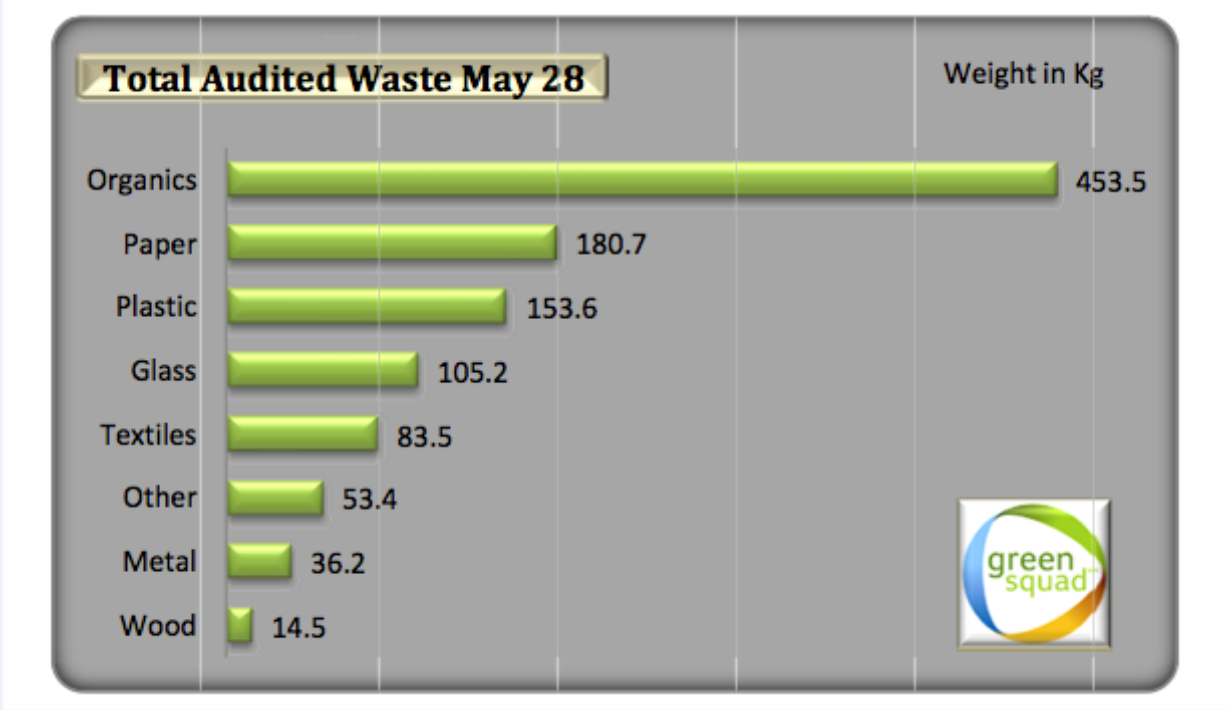

Figure 7: Waste Audit Graph for Leeds and the Thousand Islands (Green Squad, 2009)

The need for more data collection was recognized by the Waste Management Committee, in their Waste Management Plan; furthermore, in their Phase One implementation Report the Committee lists some data that should be collected immediately, such as the leachate conditions of each landfill, and data on possible curbside collection. Overall, data is required in order to help establish a baseline of the amount and composition of waste in the township, monitor changes in waste over time, and help inform waste management decisions. Later a case study of Fraser Valley, British Columbia will be discussed which will emphasize the importance of data collection and what can be done if sufficient data is collected.

Furthermore, township representatives believe that having one landfill can have positive environmental effects. It can increase the lifespan of the landfill by now having the resources for compactors and shredders; it allows townships to close other landfills, like what TLTI is aiming to do. Moreover, large landfills make implementing curbside pick-up more feasible, which increased recycling to 60% in Rideau Lakes ("Township of Rideau Lakes", 2011). The Waste Management Committee of T.L.T.I. examined the possibility of operating only one landfill site instead of operating three as it does

now (Jarrett et al., 2009). The Committee believes that having only one site in operation would be economically beneficial, as it would decrease the cost/tonne of waste disposal (Jarrett et al., 2009). James Lolley, Chair of the Committee, stated that "Yes, it is much more sustainable to manage a single waste site, and this is the thrust of our Integrated Waste Management Plan. However, it will require the implementation of roadside collection so our next step is to study the cost-benefit of this" (Interview). It was proposed to Council that over several years the Lyndhurst and Escott Waste sites be filled to capacity and then closed, while the Lansdowne site remains operational using shredders and compactors to help decrease space taken up by waste (Jarrett et al., 2009). For South Frontenac, their Waste Recycling Strategy does not mention the desire to consolidate the six current landfills but if the option came up it is recommended that South Frontenac consult the Leeds and the Thousand Islands' Integrated Waste Management Plan. Finally, although the Ontario Ministry of the Environment has certain standards for landfill liners, larger landfills have the ability to receive newest lining technologies and upgrades (Williams, 2005). Overall, townships with larger, consolidated landfills have the ability to unite their resources and technology into a few landfills that can have positive environmental effects, be more cost effective for tax payers and increase data collection.

In contrast, many small landfills often have opposite effects. There are less resources and attention feasibly offered for smaller landfills, so as a result they are often less environmentally sustainable. Specifically, South Frontenac representatives said they are unable to provide resources for six weighing systems and at this time South Frontenac is not looking to combine their landfills like Leeds and the Thousand Islands is (Interview). However, smaller landfills have the opportunity for recycling methods that can be tailored towards their specific needs. In the case of South Frontenac, they are going to be implementing a hay plastic collection starting January 2012. This was organized due to the local farmer interest and support for the program that representatives from South Frontenac believe would not have been possible if initiated on a large scale system. Furthermore, in considering landfill size and location it is also important to be aware of the "not in my backyard" (NIMBY) mentality. Many communities do not want to be in close proximity to landfills since they believe they are unpleasant, pose a threat to their health and the environment, or reduce the value of their property (Barbalace, 2001). The repercussions of NIMBY mentality include the discouragement of people from knowing where their waste goes or how much waste they are producing. By having waste in your "backyard," one is more aware of its effects and detriment to the environment; as a result, communities will attempt to have landfill sites placed elsewhere (Barbalace, 2001). Thus, having many smaller landfills can be beneficial for the environment because they foster a community of waste-awareness, in which the

citizens experience the effects, of their waste, first hand. Along with the NIMBY mindset, "environmental racism" has been debated to exist when poor and/or minority communities are given a disproportionate amount of environmental burdens, including being selected as the location for landfill sites (Bullard, 1993). According to Bullard, environmental racism is defined as the organized placement of hazardous-waste disposal sites, sewer treatment plants, landfills, incinerators, lead smelters, and other "risky technologies" within black communities (1993). In the past, socio-economically depressed and minority communities have received a disproportionate share of such facilities. Few are located in the suburbs, where most middle-class white residents live. In the United States, Latino neighborhoods and Indian reservations also are receiving the brunt of these pollutions, and unfortunately state governments have been ineffective in protecting minority communities from this injustice. Now that the issue of "environmental racism" is becoming more widely accepted because of concrete evidence from cases like child lead poisoning, communities are starting to fight back (Thomas Reibling, 2001). National movements for environmental justice have gained momentum but "environmental justice" is still an issue. However, if waste is kept within the communities that produce the waste then it does not allow "environmental racism" to exist because the waste does not get shipped to socio-economically depressed or minority communities.

A representative from SFT commented that the issue of "out of sight, out of mind," or NIMBY, needs to be considered when deciding to move towards larger, consolidated landfills because the representative feels the citizen's have a better appreciation of their waste when landfills are controlled on a small scale. Thus, smaller landfills, although more cumbersome and less resourced, make the neighboring residents more aware of their waste produced and discourage environmental racism.

12.2 Waste Diversion

12.2.1 Source Diversion: Education

The TLTI Waste Management Committee has discussed the importance of educating the public on waste management in both their 2009 TLTI Waste Management Plan and 2011 Phase One Implementation Report. In the Plan, the initiation of a public education program is recommended, which would begin by focusing on increasing recycling (Jarrett et al., 2009). The ultimate goal of this program would be "To encourage and educate [the township's] ratepayers to reduce and divert the quantity of

waste destined for the landfill" (Jarrett et al., 2009). The Committee proposes this be done through means such as improving the township's website, creating a waste management quarterly newsletter, and making a complete list of all hazardous waste items disallowed in the landfills easily accessible to all residents (Jarrett et al., 2009).

Furthermore, in their Phase One Report the Committee expressed their desire to the TLTI Council to begin a waste management public awareness campaign. The Committee estimated the cost of this campaign could be $30,000 in its first year and asked Council to approve an initial $10,000 for the campaign in 2011 (Lolley et al., 2011). This campaign is expected to include videos, posters, newspaper articles and meetings with residents to educate and gain public participation in diverting as much waste as possible from the landfills. The Committee's Phase Two Report will focus on developing this public awareness campaign in greater detail (Lolley et al., 2011).

For SFT, their recently published *Waste Recycling Strategy* highlights the need for training of key program staff and public education and promotion programs (2011). Their belief is that "regardless of the size or type of municipal program, training acts as an enabler of performance, facilitating the achievement of objectives in a cost-effective manner" (*South Frontenac Waste Recycling Strategy*, 2011). In conjunction with the training of key program personnel, the strategy aims to increase the education within South Frontenac in order to make the residents more aware of possible waste diversion methods. That said the strategy aims to increase awareness regarding the use of Blue Box Recycling, not composting, as it is not yet implemented in SFT (*South Frontenac Waste Recycling Strategy*, 2011). During phone interviews with South Frontenac representatives, they emphasized that education is SFT's primary concern in the next couple of years. SFT currently believes it is sending mixed waste-diversion messages, so it wants to align its messages with Kingston and other townships within the FABR. A SFT representative stated that the township hopes to develop a good education program in the next year to year and a half (Interview). Since SFT recently implemented roadside pick-up at the final two landfills, the representative believes the equal level of service is a step in the right direction, for education, because it allows SFT to send out consistent waste diversion messages (Interview).

Overall, SFT is at the onset of its education program, but has yet to determine what its budget for this endeavor will be. Since the representatives from SFT are looking for opportunities to combine their message with other townships, this report believes involvement from the FABR or future ENSC 430* groups could aid in this objective. This will be discussed further in the recommendations section.

12.2.2 Collected Waste Diversion: Biogas

12.2.2.1 Introduction

Long before humans or technology, the cornerstone of our continually evolving planet has been the proverbial 'cycle of life'; natural biomass grows, flourishes, dies, is decomposed and then is reincorporated in to new organic matter. In this manner, our environment and the creatures that inhabit it have evolved in to the world as we know it today.

This process can also be thought of as a cycling of energy from one state to another within an ecosystem. From a waste management perspective, the most important point in the natural lifecycle of organic matter is its decomposition. At its very basic, if organic matter is left undisturbed within a landfill, microorganisms within the ecosystem will slowly degrade it and the contained energy will be either used by the microbes as fuel or lost to the environment. This loss of energy has provoked researchers to consider if energy from the decaying organic waste could in any way be harnessed for human use.

This thought process is by no means a modern concept and many parts of the world including Europe and Southern Asia have experiment with the idea for centuries (Kossmann and Ponitz, 2005). It has been experimentally found that the most efficient way to harness decaying organic matter is to trap its off-gases in a controlled environment (Angelidaki et. al, 1998). These gases, known as 'biogas', are highly combustible and can ignited to power internal combustion engines and, thereby, create harnessed energy ("Introduction to Anaerobic Digestion", 2007).

Biogas creation can be understood by analyzing the microorganisms that are responsible for organic matter decay. With the exception of the top layers of a landfill, most of the waste is subjected to conditions where no oxygen is present. These anaerobic environments are excellent breeding grounds for particular species of bacteria that work optimally in oxygen-free environments. Such bacteria use complex organic material as a food source and emit primarily carbon dioxide and methane as gaseous byproducts (Bogner et al., 1995). This gas, if it can be trapped in large quantities, is combustible and can be harnessed.

In a landfill, this biogas diffuses in to the surrounding environment and remains unexploited. If, however, instead of placing organic waste in to a landfill, it is fed in to a specifically designed anaerobic container that is optimized to contain the necessary microorganisms with controlled variables such as temperature, water content and acidity, the produced biogas can be trapped and then used to create energy. This container is known as a biogas digester and recent technological advances have optimized

its function such that it is not only functional but also profitable for its owner. The required organic matter can come from manure, food, sewage sludge and other household waste and the produced energy can be used as electricity to not only power the operation but is present in excess to use for other means.

A flow diagram outlining the breakdown of complex organic waste, as can be found entering landfills, is seen in Figure 8:

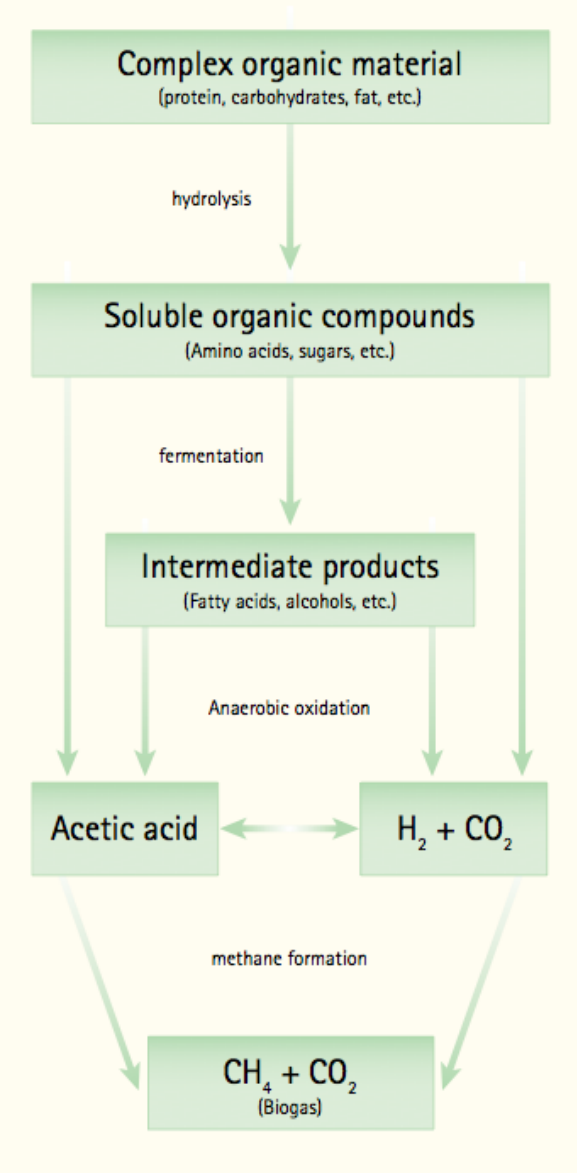

Figure 8. Schematic illustration of the degradation of organic material by anaerobic microorganisms in to biogas ("Biogas: Renewable Energy from Organic Waste", 2004).

The primary drawback to this sophisticated system is the cost. Setting up a biogas operation requires a large initial capital investment, which will be discussed further below. Furthermore, conditions within the digester must be continually monitored to ensure that biogas production is optimal. Regardless, given the large amount of organic waste present in agriculture and MSW, many

companies worldwide have taken to refining the chemical processes by which biogas can be produced and how much energy can be retained from its combustion. It is estimated that Germany, a country at the forefront of the implementation of anaerobic digesters, has over 4000 biogas systems online for energy production ("Introduction to Anaerobic Digestion", 2007). Other nations, including Canada, have begun investing in biogas production for the conversion of their organic wastes into usable energy.

12.2.2.2 Importance

Biogas provides a direct alternative for organic waste going to landfills. Traditionally, biogas production facilities have been set up on dairy farms in a closed loop wherein the organic inputs from the farm have supplied the biogas production and the electricity produced from the process is used to power the farm and can be sold back to the grid. In this study, biogas generators will be considered based on the idea of inputting organic materials previously headed to landfills as a means of diversion. This diversion of waste from a landfill to an energy producing process is not only more sustainable for the environment, but also provides usable energy for the local community. It is acknowledged that this representation is simplistic in its characterization and further details will be discussed below, however, the core importance of the process remains the same.

12.2.2.3 Feasibility

12.2.2.3.1 – Biogas Implementation

Two case studies will be examined in order to look at the feasibility of biogas implementation. Firstly, Ledgecroft Farm, a biogas dairy farm located within the FABR boundary, was visited in October 2011. The following results are based off an interview done that day. Secondly, a case study of Fraser Valley, British Columbia, is studied and compared with the townships within the FABR.

12.2.2.3.1.1 Case Study of Ledgecroft Farm

Ledgecroft farm was visited on October 2nd, 2011 (Figure 9). This farm is the only biogas farm within the FABR boundary but it represents an example of sustainable energy production and method for waste diversion that other farms can hopefully mimic in the future.

Figure 9. Biogas Facility from Ledgecroft Farm, Ontario

Overall, the Ledgecroft farm acknowledged that switching to biogas production provided many benefits:

1. The farm can run 24/7 unlike other renewable energy sources such as solar and wind
2. Being a dairy farm, Ledgecroft is ideal for biogas energy because the cattle are fed high energy feed; thus, the energy product is higher than that of other farms.
3. There is enough heat provided by the biogas to heat the owners' residence, dairy barn as well as additional energy that could run a greenhouse in the future.
4. They have a twenty-year contract to keep the biogas farm running; therefore a change of government will not affect the farm.
5. It cost approximately $3 million to assemble the biogas facility, which will be paid off in twelve years simply based on selling the energy. That does not include the money they receive from grocery stores and restaurants for taking in the organics, or the benefits they get from having better manure to put on their fields.
6. They receive 16 cents/ kWh which is higher than normal energy rates.
7. It helps keep the water and air clean, which promotes a "green" environment.

The hurdles that Ledgecroft farm faced while implementing their biogas farm are mostly related to dealing with Hydro 1, Ontario Ministry of Environment, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and electrical issues when connecting their energy to the grid. Since Hydro 1 is a distributor of mostly nuclear energy, dealing with biogas facilities was new to them. Thus, it was an arduous task, due to Hydro 1's high safety standards, which required Ledgecroft farm to prove that they had all the necessary safety measures in place. To complete this they hired a consultant, who was successful. Furthermore, they needed a contractor to distribute the energy, which was not originally anticipated. However, when asked if they would do it again, all of the owners said that they would "do it again in a heartbeat," which is a good sign for households or companies thinking of developing a biogas facility (Ledgecroft Interview).

12.2.2.3.1.2 Case Study: Fraser Valley, BC

In evaluating the feasibility of biogas implementation within the FABR, this report also chose to look for comparable cases where biogas digesters have been investigated at a level greater than a single farm. While no township or area was exactly similar in population, land usage, climate and other similar variables, the investigation of biogas implementation in Fraser Valley, British Colombia is a useful model for the townships with the FABR to potentially build off of. As seen in Figure 10, Fraser Valley is an area stretching approximately 100 kilometers east of Vancouver to the foothills of the Rocky Mountains.

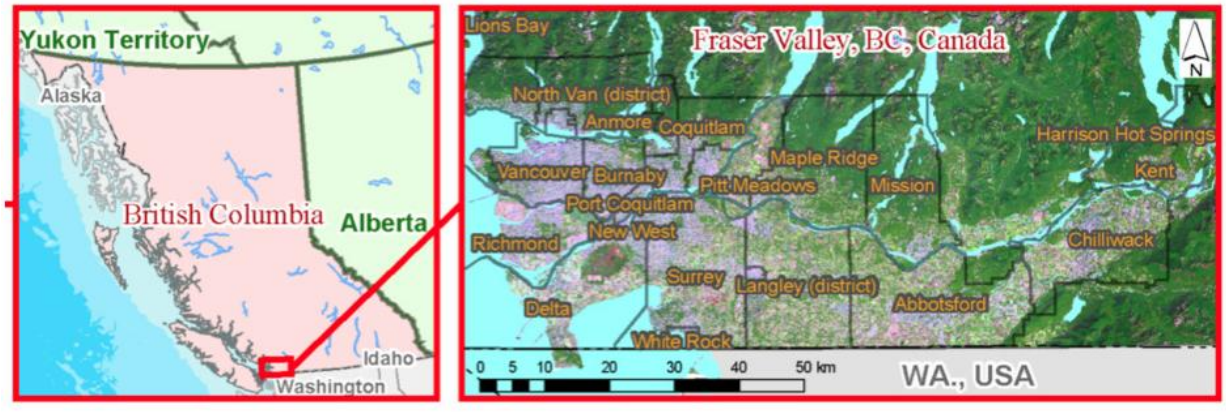

Figure 10. Geographic location of Fraser Valley, British Colombia ("Feasibility Study", 2007).

Similar to the FABR, Fraser Valley is not a legal jurisdiction but rather a group of cities and townships that reside in the same geographical area, along the Fraser River basin. The population of the area is

divided in to two categories: Metro Vancouver, with a population of 2,116,965 and the Fraser Valley Regional District (FVRD) rural region, with a population of 257,031 ("Feasibility Study", 2007).

In 2007, the British Columbia Bioproducts Association led an initiative including British Columbia's Ministry of Agriculture and Lands, Ministry of Energy, Mines and Petroleum Resources, Ministry of Environment, BC Greenhouse Growers' Associated, BC Hydro, BC Milk Producers Association, National Challenges Systems Inc. and Great Pacific Bioproducts Ltd., to commission a study concerning the feasibility of biogas implementation in the area as a means to divert local organic waste ("Feasibility Study", 2007). The study was performed by Electrigaz Technologies Inc. and was published in November of 2007.

Fraser Valley is home to a large amount of dairy farming and, as such, manure was identified as the primary source of organic waste that could be used to power biogas digesters (see Figure 11) ("Feasibility Study", 2007). The study showed that over the approximately 3.3 million tonnes of organic waste per year, 82% could be accounted for by manure alone.

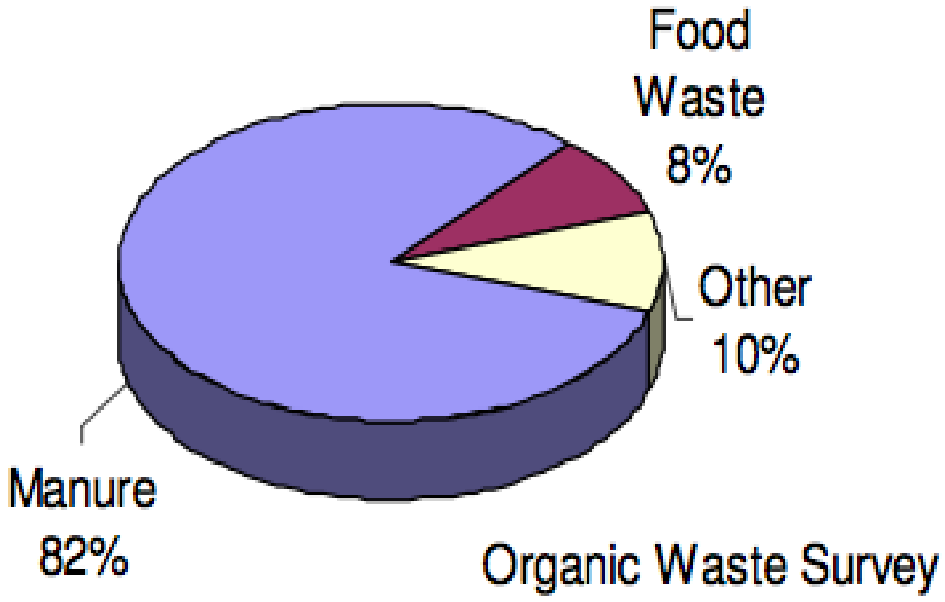

Figure 11. Results of the organic waste survey performed by Electrigaz Technologies for Fraser Valley, BC ("Feasibility Study", 2007).

As such, the study found that the most economically viable set up for Fraser Valley would be to situate biogas anaerobic digesters on farms running primarily on agricultural organic waste and accepting off-farm food waste ("Feasibility Study", 2007). The study went further to quantify each potential organic waste source's energy contribution in biogas production as seen in Figure 12.

Material Description	Quantity *tonnes/year*	Waste %	Origin	AD Potential
Manure				
Cow	1 750 008	52.5%	Farms	Excellent
Poultry	472 040	14.2%	Farms	Medium
Pig	388 718	11.7%	Farms	Good
Other	102 894	3.1%	Farms	Varies
Sub-total	*2 713 659*	81.5%		
Food Waste				
Landfill organics	216 000	6.5%	Residential and ICI*	Good
Composting facilities	25 000	0.7%	Residential and ICI	Excellent
Backyard composters	15 000	0.4%	Residential	Excellent
Fruit and Veg. Farms	23 600	0.7%	Farms	Good
Sub-total	*279 600*	8.3%		
Other				
Grass Clipping	25 000	0.7%	Residential and ICI	Good
Fat, Oil & Grease	10 300	0.3%	ICI	Excellent
Rendering Material	150 000	4.5%	ICI and Farms	Excellent
Septage	90 000	2.7%	Residential	Poor
WWTP Sludge	67 000	2.0%	Residential and ICI	None
Sub-total	342 300	10.2%		
Grand total	***3 335 559***	***100%***		

Figure 12. Organic waste survey results in Fraser Valley, BC ("Feasibility Study", 2007).
ICI: Industrial, commercial and institutional; AD: Anaerobic digestion; WWTP: Waste water treatment plant.

In spite of this data collection and research, the study found that its environmental benefits would not result in a long-term profitability for Fraser Valley due to the current economic policies in place in British Colombia, with regards to renewable energy sources. As a result, the report concluded that "anaerobic digestion cannot develop to its full potential in BC" and provided examples of policies adopted in Germany that are more favorable to biogas production ("Feasibility Study," 2007).

With relation to the FABR, this study highlights several crucial hurdles that the biosphere or any interested townships may face when considering biogas implementation. Fraser Valley has considered

agricultural organic waste as their primary fuel for biodigesters but Figure 12 also shows that 216,000 tonnes per year of landfill organics could be used in the process. While this report focuses primarily on landfill organic diversion, the FABR may wish to consider a biogas system with multiple inputs including manure and landfill organics in order for the digester to be as efficient as possible. Furthermore, Fraser Valley is home to a much greater population and subsequently produces much more waste than the FABR. It may not be feasible for a single township within the FABR to implement such a project and may require the partnership of several townships in order to both raise enough capital and have enough organic waste to sustain the project. Funding was the critical issue in British Colombia and will be discussed in detail in *Biogas Funding*.

While ultimately proving unsuccessful in Fraser Valley, this case study elucidates the need for excellent data collection in order to even consider biogas implementation with any seriousness. Current means of measuring waste disposal and landfill usage are very crude within the FABR and are often based on extrapolation or estimation. In order for any part of the FABR to consider a waste diversion opportunity, such as biogas, there must be an accurate system of data collection put in place in order for a feasibility study to take place to determine the project's potential viability.

12.2.2.3.2 – Biogas Funding

After interviewing with the Green family from Ledgecroft Farms, it was determined that one of the largest setbacks to implementing a biogas farm is connecting their electricity to the grid and getting a long-term energy contact, as discussed. Conveniently, some of the programs, which were researched by Queen's 2010 energy group, are still supportive of new renewable energy developers.

The Ontario Power Authority has two programs, FIT and microFIT, which are available for private energy manufacturers that produce more than ten kilowatts or less than ten kilowatts, respectively. These programs are geared towards biofuel, biogas, solar, wind, hydropower and landfill gas, with an objective to help Ontario phase out coal-powered electricity generation by 2014, boost the economy, create new green industries and jobs, and develop new renewable energy technologies. For the FIT programs, the government will buy the produced energy at or above market price. This is a great incentive for new properties that are thinking of implementing a biogas facility (Ontario Power Authority - Feed-in Tariff Program, 2011).

Furthermore, ecoAGRICULTURE Biofuels Capital initiative was proposed by Natural Resources Canada and will support the instillation, enlargement of biogas systems, connecting to the grid, and funding enticements for new biogas facilities (ecoACTION Canada, 2010).

12.2.2.3.3 Interest

12.2.2.3.3.1 South Frontenac Interest

Upon speaking to a representative of the SFT through a series of interviews, it was indicated that the township had not previously considered a biogas facility within their jurisdiction (Interview). The representative was unaware of the general principles of biogas creation and subsequent energy production. After further conversation outlining the basics of a biogas digester, the representative agreed in principle that the project would have a positive impact on the SFT but also made note that the capital investments required to set up such a facility may not be feasible for the township. Furthermore, the representative also raised an important sustainability issue: would the township be interested in investing in to a technology that put emphasis on increased waste generation in order to power its operation? Should the township be shifting its focus to address any unnecessary waste being produced instead of installing technologies to deal with the unsustainable repercussions of excess waste production? These points were certainly valid and have shaped this study's recommendations appropriately.

12.2.2.3.3.2 Leeds and the Thousand Islands' Interest

In the TLTI Committee's 2009 Waste Management Report, amongst other opportunities, the Committee examined the possibility of introducing a biodigester into the township. The report included background research, early discussion with Hydro 1, and preliminary calculations on the cost of obtaining and operating a biodigester (Jarrett et al., 2009). Although the Committee is still in the process of gathering information, in the report it is stated that: "The committee is confident the revenue-making possibilities of a biodigester warrant examining this option in detail" (Jarrett et al., 2009). There is therefore already knowledge and interest in biodigesters as a means of organic waste diversion and electricity production**.**

In contrast to Ledgecroft farms, the report examined installing a biodigester that would use primarily septage as a source of organic matter (Jarrett et al., 2009). This is because the Committee does not believe the township has enough household organic waste to support a biodigester alone. A possible site for the biodigester is the Township's Lansdowne property, where the Lansdowne landfill site is currently located. There is space at this site and proper accessibility via roads and highways (Jarrett et al., 2009).

James Lolley believes the major hurdles to introducing a biodigester are "determining the availability of feedstock, Council's willingness to be involved and connection to the grid" (Interview).

13) Recommendations

13.1 Recommendations for the SFT and TLTI

For TLTI, although a Waste Audit was performed in 2009 it was short and was conducted solely in the Municipality of Lansdowne, at the Lansdowne Waste Site (Green Squad, 2009). Further data must be collected in order to establish a baseline from which to monitor and track changes in Township waste. The need for more data collection is recognized by the TLTI Committee who stated in the *Waste Management Report*, "The lack of accurate data concerning waste volumes, weight and composition has been a challenge for the committee...Good data is required if strategic decisions are to be made regarding waste and recycling composition." (Jarrett et al., 2009). In addition, in their *Phase One implementation Report* the Committee lists some data that should be collected immediately, such as the leachate conditions of each landfill and data on possible curbside collection. (Lolley et al., 2011).

For SFT, it is recommended that the township looks into having a waste audit done on their six landfills in order to obtain some basic, concrete data relating to the landfill's waste accumulation. In the future, the feasibility and cost: benefit of minimizing their six landfills may want to be analyzed as well.

Overall, for both of these townships, further data needs to be gathered before the economics of implementing biogas waste diversion can be considered. Thus, this report supports increasing data accumulation throughout both of these townships, if possible. That said, it is understood that data collection is not always economically feasible so, at the least, it is recommended that the townships further look into implementing organic waste collection.

13.2 Recommendations to FABR

Firstly, it is recommended that the FABR encourage townships to improve their waste management practices where they are lacking. The attribute table can be used as a resource to illustrate where townships could divert more waste through means such as composting, greater recycling, and providing appropriate electronic waste and hazardous waste disposal facilities.

In conjunction with this, is it recommended that the FABR host meetings or conferences with waste management representatives from all of the townships in the FABR. This would provide the representatives with the opportunity to gain an understanding of the waste management practices in the surrounding townships, and offer a forum for the sharing and comparing of waste management information. In particular, this could be beneficial in facilitating discussion on the development of a standard method of waste management data collection and education within the FABR. As discussed earlier, data collection is not adequate in SFT and TLTI, and the methods of data collection and types of data collected are not consistent across the different townships. Beginning consistent data collection in all of the townships would allow the FABR to establish a baseline of waste in the Reserve, permit townships to compare their data in the future, and it would be useful in determining the feasibility of waste management opportunities, such implementing a biogas facility.

Finally, since both of the townships are looking to improve their waste management education, the FABR could be helpful in connecting consistent educational messages throughout the FABR and hopefully with Kingston too. Representatives from both the SFT and TLTI believed that having the FABR board involved with relaying a consistent waste management message would be beneficial for the success of their educational programs (Interview).

13.3 Recommendations to Future ENSC 430* Groups

In the future, ENSC 430* groups could learn from and expand the attribute table and ArcGIS maps prepared for this report. They could help the SFT and TLTI consolidate a waste management educational message that could be used across the FABR townships. Furthermore, since MSW has been studied in some depth in this report, future groups could look to study other types of waste within the FABR like gaseous or liquid wastes. Moreover, the groups could look at closed or decommissioned landfills and whether or not they have any role to play in FABR's waste management cycle. Finally, this report discusses biogas as an opportunity for waste diversion; however, is a process dependant on increased waste production really the answer? Future groups could research other alternatives to efficiently manage current organic waste and/or other methods of waste diversion.

14) Conclusion

Proper waste management provides an important opportunity for the Frontenac Arch Biosphere Reserve to continue to be at the forefront of sustainability as a part of UNESCO's Man and the Biosphere program. Given this report's study of municipal solid waste within the region, and more specifically in the townships of South Frontenac and Leeds and the Thousand Islands, it can be seen that while landfill use is adequate in handling the area's waste, opportunities such as education and organic waste diversion exist for increased sustainability. Perhaps most importantly, this information has never previously been compiled in one document for the entire FABR and, as such, it is hoped that the availability and sharing of this information can lead to the facilitation of discussion within and between townships on the issue of waste management. It is acknowledged that the report's findings would best be implemented as a large-scale collaboration between all of the communities within the FABR and it is hoped that given the presented information, the Frontenac Arch Board of Directors can aid in the necessary networking required to continue the region's excellence in sustainability as it pertains to waste management.

15) Works Cited

Angelidaki, I., Ellegaard, L., Ahring, B.K. 1998. “A Comprehensive Model of Anaerobic Bioconversion of Complex Substrates to Biogas.” The Anaerobic Microbiology/Biotechnology Research Group.

Barbalace, Roberta C. Environmental Justice and the NIMBY Principle. EnvironmentalChemistry.com. 2001.

“Biogas: Renewable Energy From Organic Waste”. 2004. Swedish Biogas Association.

Bogner, J., Spokas, K., Burton, E., Sweeney R., Corona, V.. 1995. “Landfills as Atmospheric Methane Sources and Sinks”. Chemosphere. 31: 4119-4130.

Bullard, R. D. "Waste and Racism: a Stacked Deck?" *Forum for Applied Research & Public Policy* 8.1 (1993): 29-35. Print.

Bullfrog Power. Web. 04 Dec. 2011. <http://www.bullfrogpower.com/>.

Craig, Anne. “Geotourism Charter Bestowed upon Region.” *Brockville Recorder and Times. Frontenac Arch Biosphere Reserve.* QMI AGENCY, 17 Jan. 2010.

“Feasibility Study – Anaerobic Digester and Gas Processing Facility in the Fraser Valley, British Colombia”. 2007. Electrigaz Technologies Inc.

Green Squad. 2009. Sustainability Solutions. Waste to Resource Assessment Report. Municipality of Lansdowne.

“Introduction to Anaerobic Digestion.” 2007. PlanET Biogas Solutions.

Jarrett, P., Lolley, J., Smith, C., and L.Walker. 2009. TLTI Waste Management Committee Report. An Integrated Waste Management Plan for the Township.

Kossmann, W. and Ponitz U. 2005. “Biogas Digest.” Information on Advisory Service on Appropriate Technology.

Laporte, Guy. “2010 Annual Reports Presentation to Council.” AECOM. 10 May 2011. Print.

Latimer, Vanessa. “Public Works Tender 2011 – 008: Collection & Processing of Recyclables.” Township of Leeds and the Thousand Islands (2011). Print.

Lidster, Kevin. *Sustainable Waste Management.* Rep. LidsterCorp Ltd, 2001. Web

Lolley, J., Merkley, W., Jarrett, P., Smith, C., and S. Blakey. 2011. Township of Leeds and the Thousand Islands. Waste Management Committee Report. Phase One Implementation.

“Man and the Biosphere Programme.” *Ecological Sciences for Sustinable Development .* UNESCO. Web. 2011.

Matheson, L.J. 2010. “Council Studies Landfill Sites.” The Gananoque Reporter. http://www.gananoquereporter.com/ArticleDisplay.aspx?e=2181637&archive=true

Noton, A. "The Importance of Waste Management." *Ezine Articles* 9 Aug. 2010. Print.

Ontario Ministry of the Environment. 2011. Waste Diversion. http://www.ene.gov.on.ca/environment/en/subject/waste_diversion/index.htm

Read, A., P. Phillips, and G. Robinson. “Landfill as a Future Waste Management Option in England: the View of Landfill Operators.” *Resources, Conservation and Recycling* 20.3 (1997): 183-205. Print.

Rideau Environmental Action League (REAL). Feb 2011. Municipal Waste Options: Township of Rideau Lakes. http://www.realaction.ca/muniwaste/rideau_lakes.html.

"South Frontenac: Garbage & Recycling Information.” *Welcome To South Frontenac The Township of South Frontenac*. Web. (2011) <http://www.township.southfrontenac.on.ca/Garbage>.

South Frontenac Waste Recycling Strategy. Rep. The Emerald Group and Waste Diversion Ontario, 5 Apr. 2011. Web

Township of Leeds and the Thousand Islands. 2010. “Township News” Volume 5, issue 1.

The Township of Leeds and the Thousand Islands (TLTI). 2010. “Waste Management Committee Report.” Township News. Volume 5, Issue 1, page 4.

Township of Leeds and the Thousand Islands. 2009. Waste and Recycling Information. http://www.leeds1000islands.ca/ContentPage.cfm?PageID=15

Township of Leeds and the Thousand Islands. 2009. Public Works Department – information. 2009. http://www.leeds1000islands.ca/ContentPage.cfm?PageID=35

Township of Rideau Lakes. 2011. Waste Pickup Schedules. http://www.twprideaulakes.on.ca/waste-pickup.html

Thomas Reibling, Ellen, Gregg P. Macey, Xee Her, and Jonathon Ericson. "An Investigation of Environmental Racism Claims: Testing Environmental Management Approaches with a Geographic Information System." *Environmental Management* 27.6 (2001): 893-907. Print.

"Township of Rideau Lakes - Township Waste Management." *Township of Rideau Lakes, Ontario, Canada*. Web. <http://www.twprideaulakes.on.ca/landfills.html>.

Williams, Paul T. *Front Matter*. 2nd ed. Chichester, UK: Wiley & Sons, 2005. Print.

"Ontario Power Authority - Feed-in Tariff Program." *Home Ontario Power Authority - Feed-in Tariff Program*, 2011. Web. <http://fit.powerauthority.on.ca/what-feed-tariff-program>.

16) Appendix

16.1 Interview format and questions

Dear [Sir/Madam],

My name is [_] and I am contacting you for your valuable input into our study of solid waste management in the Frontenac Arch Biosphere Reserve as part of the undergraduate course ENSC 430 Hon. Project In Environmental Sustainability at the School of Environmental Studies at Queen's University.

This report will look at the state of the environment in regards to waste management in this Biosphere Reserve. Environmental indicators pertaining to FABR's municipal landfills will be examined to determine their impact on FABR's environment and to allow us to present new opportunities for the FABR to employ in its waste management strategy.

Our objective as a class is to provide the FABR with monitoring methods and results for use in their State of the Environment Report.

We are currently collecting data on [_] and were wondering if you could please provide your best answers to the following questions in regards to your participation with [landfill A/township X].

In addition, would you mind taking a moment to review the attached ethics protocols for further information about our project. We need written consent that you have read and understood these practices in accordance with proper ethical procedures.

1. How many open landfills are in the Township and where are they located?
2. What types of waste do you accept? (Ask anything missing in the table, not found on the websites. Ex. Composting, e-waste)
3. Do you require bag tags?
4. Do you require clear bags? If not, do you have a way of ensuring that recycling is taking place properly?
5. What type of material do you use to cover the landfill
6. How many times a month is the landfill covered/compressed?
7. Do you have a way of measuring traffic i.e. number of cars per day, average weight dumped by individual cars?
    a. Do you have data of this?
8. How many separation bins do you have? What are they?
9. Are there any specific policies that govern the operation of this landfill that you are aware of?

16.1 Interview format and questions Continued

10. Have any members of the municipality or private companies come to inspect your landfill and its operation? If so, how many times a year does this occur?
11. Do you know the lifespan of this landfill?
12. How much traffic is there at each of the landfills? Or where can I find this data?
13. Are your practices consistent with other local landfills?
14. Are you aware of other local landfill practices?
15. Are you aware of biogas farms and their operations?
    a. Would such a farm in your Township help divert waste from the landfills?
    b. Do you see this as a feasible option?
        i. Why? Why not?

Thank you very much for your time and we look forward to hearing back from you.
If you have any further questions or comments, please don't hesitate to contact me at [_]

Questions on the Waste Recycling Strategy in South Frontenac:

1. What education programs have taken place to make the community more aware of bag tags, recycling limits, issue of clear bags and other incentives?
2. Has anything been done to the ReUse website?
3. The document says "The Provincial target diversion rate is 60% and the Township currently diverts approximately 20%". Do you hope to reach the 60% goal in 5 years? If not, how long?
4. Does South Frontenac plan to make recycling mandatory or have increased fees for garbage?
5. "Geographic size, seasonal access restrictions, rural collection issues and multiple lake boundaries affect recycling collection costs and efficiencies." Is anything being done to deal with these issues?
6. Goals and Objectives: how successful and what initiatives have been taken to fulfill these?
7. Since only ~20% of municipal solid waste is diverted to blue box but ~48% could be diverted (~2400 tonnes), what measures is South Frontenac taking to ensure its residents correctly recycle that extra 28% (~1400 tonnes)?
    a. The WRS stated that the largest difference is recycling would be from paper so is that where the promotion is being focused?

16.1 Interview format and questions Continued

8. Different initiatives:
    a. Public education and promotion program
        i. How successful has the P&E message been with aligning to Kingston's P&E.
        ii. Does the website www.southfrontenac.reuses.com have any way to tell how many people access it? How successful has it been?
    b. Training of key program staff
        i. "Regardless of the size or type of municipal program, training acts as an enabler of performance, facilitating the achievement of objectives in a cost-effective manner." What was the *Pg. 45, Blue Box Program Enhancement and Best Practices Assessment Project, Final Report, July 2007* based off of?
        ii. Is the south frontenac planning to bring in outside knowledgeable people to train the key program staff?
    c. Bag Limits/Tags
        i. Have any measures to change fees for garbage → bag limits been put into place?
    d. Optimization of recycling depots
        i. It says "where collection programs are not sufficient for some properties" …does that entail that some places do not get recycling options?
        ii. Cost: benefit of improving recycling depots vs. expanding collection programs?
9. Future Initiatives:
    a. Following Generally Accepted Principles for Effective Procurement and Contract Management. (GAP)
        i. Have any of the contacts changed within the South Frontenac township since the release of this report and requirements to follow the GAP?

16.2 Group Workshop

Please answer the following questionnaire with honesty. Keep in mind that your answers are anonymous.

(1) Strongly Disagree (2) Disagree (3) Unsure (4) Agree (5) Strongly Agree

1. I compost and participate in using the “green bin” regularly.

1 2 3 4 5

2. I recycle and participate in using the “blue bin” regularly.

1 2 3 4 5

3. If I recycle, I separate my recyclables appropriately.

1 2 3 4 5

4. Waste management is better controlled when it is highly managed by the Municipality.

1 2 3 4 5

5. Landfills are the best option for dealing with municipal solid waste.

1 2 3 4 5

6. I know exactly where my garbage goes when I put my waste to the curb every week.

1 2 3 4 5

7. Solid waste could be better managed through diversion methods, such as biogas production

1 2 3 4 5

8. In my opinion, waste diversion through biogas production is a realistic option for an entire municipality.

1 2 3 4 5

Group Workshop – Session #1

Agriculture and Food

In relation to agriculture and food, what methods of waste reduction do you see plausible? Currently, do most farms dispose of their waste to landfills or reuse it for agricultural purposes? Have you found any other farms, besides the one we visited, that use biogas?

16.2 Group Workshop Continued

Biodiversity

What methods of waste reduction do you see plausible? By reducing waste, how would that impact the biodiversity of the FABR?

Biosphere Reserve Awareness

Currently in the biosphere, have you encountered any signage which promotes recycling, reducing waste or reusing materials in order to facilitate waste management? What are methods of promoting waste management and are they plausible to incorporate into the FABR?

Climate Change

What methods of waste reduction do you see plausible? By reducing waste, would that have an impact on climate of the FABR? Do you see biogas as a potential candidate for waste diversion and why?

Energy

In relation to energy, what methods of waste reduction do you see plausible? Do you see biogas as a good candidate for waste diversion? Do you know how much energy is made/ month through biogas at the farm we visited? Have you found any other farms, besides the one we visited, that use biogas?

Society and Culture

Currently in the biosphere, have you encountered any signage which promotes recycling, reducing waste or reusing materials in order to facilitate waste management? What are methods of promoting waste management and are they plausible to incorporate into the FABR?

Water

What methods of waste reduction do you see plausible? By reducing waste, how would that impact the water quality and supply within the FABR? Do you see biogas as a potential candidate for waste diversion and would it help with water supply?

16.2 Group Workshop Continued

Group Workshop 2 – Session #2

Society & Culture and Biosphere Reserve Awareness: Municipality

What hurdles would we face from your group in order to implement a biogas farm?

What questions would you need answered?

Would this be economically viable for your group?

Water and Agriculture & Food: Dairy Farmers in Area

What hurdles would we face from your group in order to implement a biogas farm?

What questions would you need answered?

Would this be economically viable for your group?

Energy: Private Waste Management Contractor

What hurdles would we face from your group in order to implement a biogas farm?

What questions would you need answered?

Would this be economically viable for your group?

Climate Change and Biodiversity: FABR or Other Environmental Issues Group

What hurdles would we face from your group in order to implement a biogas farm?

What questions would you need answered?

Would this be economically viable for your group?

16.3 Waste Management Information Brochure (Screenshot)

Our Goal

The goal of our project has been to analyze and suggest improvements for current waste management practices within the Frontenac Arch Biosphere Reserve, focusing on South Frontenac Township and the Leeds and Thousand Islands

Opportunities

- Arc GIS Map
- Coordination of waste awareness educational programs
- Increased landfill efficiency
- Increased waste diversion
- Biogas energy utilization

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Frontenac Arch Biosphere Board of Directors

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School of Environmental Studies
Queen's University
Kingston, On

Nicole Allen
Sarah Kingston
Kate Roper
Anand Srivastava

Waste Management

Indicators and Metrics

1. Broad Level Indictors:

Landfill Characteristics:
- Location
- Accepted Materials
- Lifespan

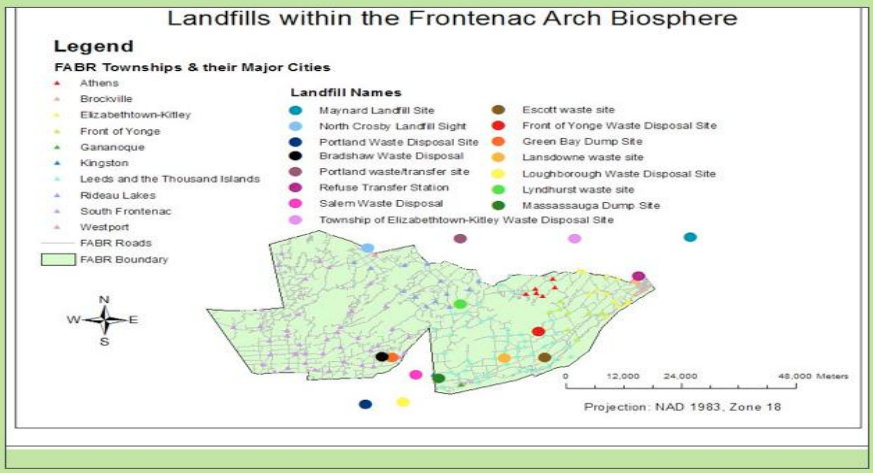
2. Case Specific Indicators:

Landfill Characteristics:
- Location
- Accepted Materials
- Lifespan
- Size
- Traffic
- Practices and Methods

Strategic Waste Management Plan:
- Local Policy
- Funding
- Participation
- Effectiveness

Waste Technology:
- Machinery
- Bag Tags
- Clear Bag Usage

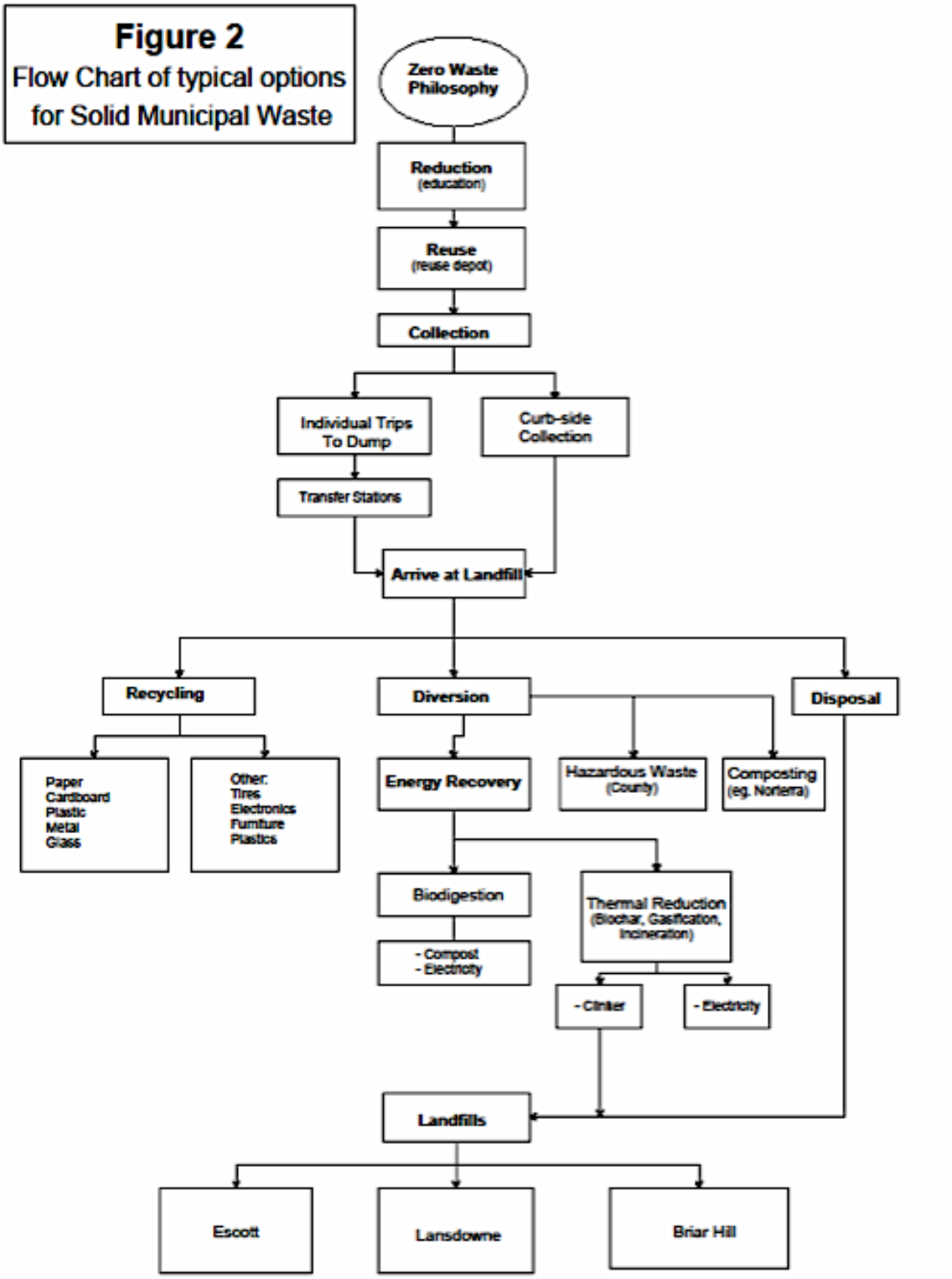
ArcGIS Map of Existing Landfills within FABR and Surrounding Area



16.4 Raw Data

16.4.1 Landfill Data

16.4.1.1 Landfill Flow Chart (Jarrett et al., 2009)



16.4.1.2 Landfill Attribute Table (Screenshot)

	Waste Collection	Transparent bags?	Bag Tags?	Open Landfills	Lifespan	Recyclables accepted	E-waste?	Compost?	Hazardous waste?	Outside of FABR boundary?
Township of Rideau Lakes	Curbside pickup, 2 bags/week, recycling 10 bag/week, each bag < 40 pounds, Seasonal summer collection - depot service for islanders/residents	Yes	Yes, $2.00 each	Portland site/transfer station	Around 15 years (To the best of Rideau representative's knowledge)	Plastics #1 to #7 (containers); Cardboard, Boxboard, Paper, Junk Mail, Newspapers, Soft covered books; Magazines, Telephone books, Cans (metal & aluminum), metal & plastic lids, coloured and clear glass bottles & jars	Yes	Free at landfill site but no curbside pick up	Specific household hazardous waste days at the site	Yes
Township of Leeds and the Thousand Islands	Landsdowne residents have curbside collection of garbage and recyclables.	Yes	Yes, $1.50 each	Lansdowne waste site	8.5 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	Yes	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	No
Township of Leeds and the Thousand Islands	Landfill drop off. Max. 40 pounds	Yes	Yes, $1.50 each	Lyndhurst waste site	10 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	Yes	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	No
Township of Leeds and the Thousand Islands	Landfill drop off. Max. 40 pounds	Yes	Yes, $1.50 each	Escott waste site	11.5 years (estimated March, 2011)	Boxboard, Corrugated cardboard, #1, 2, 4, 5 and 7 Plastics, Metal and Aluminum Cans, Aluminum Foil, Glass bottles and jars (food and beverage only), Newspapers and inserts, Magazines, catalogues and phone directories, Plastic grocery bags	No	Will be accepted soon (next 2 months)	Free Hazardous waste collection days sponsored by the United Counties of Leeds and Grenville. Collection by the Township once/year	No
Township of Front of Yonge	Pick up available at Mallorytown, landfill drop-off also available, 60 bags distributed per year to residents (20 to cottage owners)	No	Yes *Each property owner is provided with 60 tags (cottage owners receive 20) given with the first tax bill of every year, each additional bag is $1.00	Front of Yonge Waste Disposal Site	30 years	Certain Plastics 1,2,3,4,5,7. Metal and aluminum cans, certain paper, newspapers and inserts, glass, scrap steel	No	No	No	No
Township of Elizabethtown-Kitley	Pick-up avalable in northern portion of township (former Kitley township). Range tickets available for purchase, landfill drop off also available, tipping tickets available for purchase	No	Yes, $1.25 each	Elizabethtown-Kitley Waste Disposal Site	11 years	Plastics 1-7, tin and aluminium, paper products, glass, steel, scrap metal	No	No	No	Yes
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Bradshaw waste disposal	23 years	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2012	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	No
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Geen Bay dump site	20 years	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2013	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	No

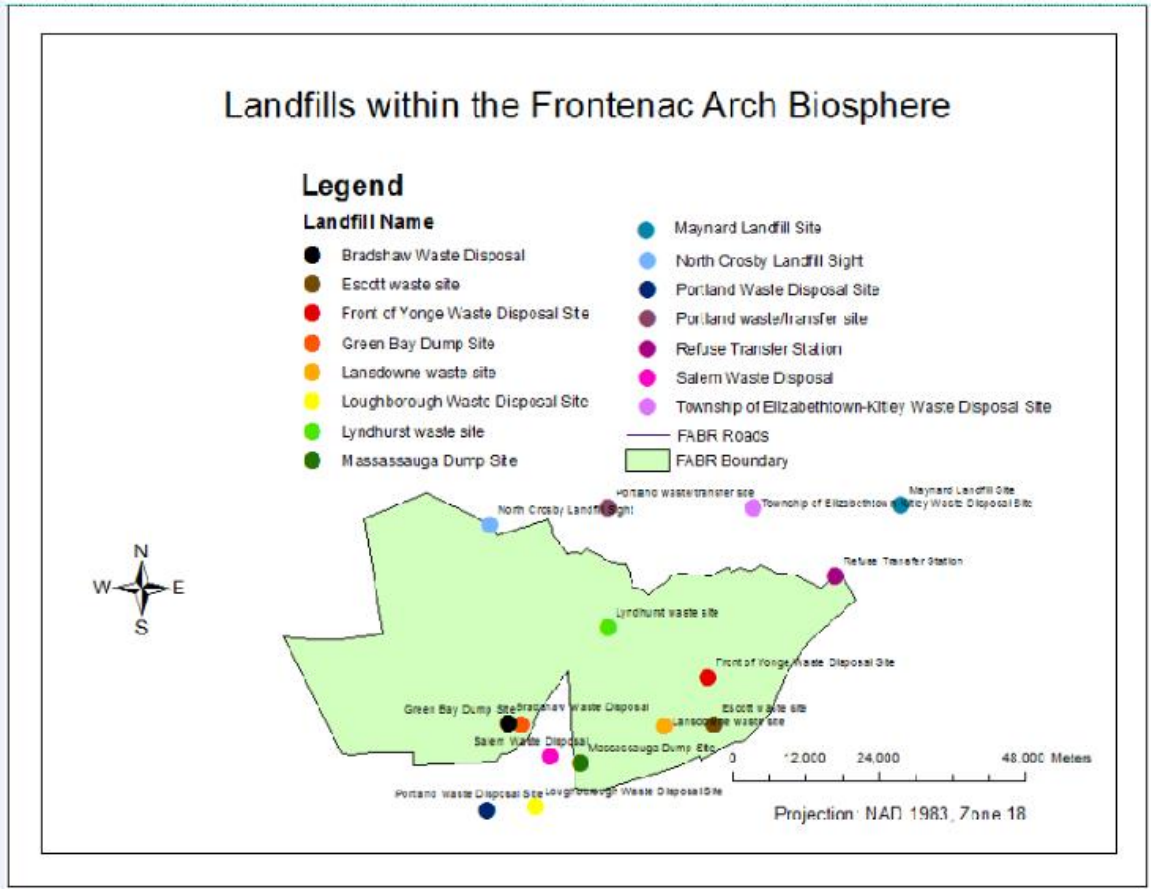
16.4.1.2 Landfill Attribute Table Continued (Screenshot)

	Waste Collection	Transparent bags?	Bag Tags?	Open Landfills	Lifespan	Recyclables accepted	E-waste?	Compost?	Hazardous waste?	Outside of FABR boundary?
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Massassauga Dump site	1 year	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2014	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	No
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Salem waste disposal	14 years	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2015	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	Yes
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Loughborough waste disposal site	12 years	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2016	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	Yes
Township of South Frontenac	curbside pickup, garbage and recycling and landfill drop-off	No	Yes	Portland waste disposal site	32 years	Plastic/metal/glass (not #3 or #7), paper/cardboard, leaf/yeard waste/tires-free to dispose of at landfill site *Hay bail plastic collection to begin January 2017	No *e-waste depot within South Frotenac	No	No *hazardous waste facility implemented june 2011, within SF	yes
Township of Athens	Pickup once/week, bags must weight <50 pounds, $5 for any amount of yard waste, curbisde waste and recycling	Yes	$1.25/each	Transfer site	N/A	Aluminium. Plastics, glass, paper, cardboard, box board	No	No *household composters subsidized for $30	No	No
Brockville	Upon Request from the following contractors: T.C.D. Waste Systems (613 802-3152) or Goodbye Junk (613 342-8800 / 613 802-3871)	Yes	No	Maynard Landfill Site	Not obtained	Cardboard, paper, plastics, metal & aluminium, coloured and clear glass. No wondow glass or dishes	No	No	Flourescent light tubes (not borken), batteries (separated out), motor oil, paint, varsols and thinners, gasoline (fee may apply based on quantity	Yes
Brockville	Landfill drop off.	No	Yes, $2.00/each	North Crosby Landfill Site	Not obtained	Green box - fiber collection, Blue box - glass, metla and plastics #1-6	No	No	No	On the border
Brockville	Pickup once/week, more than 1 bag requires a $2 bag tag	No	Yes, $2.00/each	Refuse Transfer Station	N/A	Green box - fiber collection, Blue box - glass, metla and plastics #1-6	No, e-waste goes to North Augusta Landfill	Yes, backyard composters and yard waste are collected	Yes, on designated days of the year	On the border

16.4.2 Comparison of SFT and TLTI Waste Management Strategies

Case Specific Indicators	**Metrics Used for Analysis**	**South Frontenac**	**Leeds and the Thousand Islands**
Landfill Characteristics	• Accepted Materials • Lifespan • Size • Traffic • Practices and Methods	• Currently diverts 20% of MSW to recycling → the goal is 25% within 5 years, however it could reach 48% • Currently do not separate waste effectively • Do not have weigh scales, but would like to implement them as they do not have a way currently of measuring traffic/production • Recycling is taken to Kingston, therefore recycling practices at the landfills are lacking • Hazardous Waste disposal site in effect • E-waste accepted at designated landfills	• Re-Use center for large appliances • Ward 1 "delivery station" effective in influencing better waste management practices • Plastics and glass now go to landfills, rather than being collected by landfill contractor (in the process of contracting this stage of recycling out to a MRF) • WEEE Program (e-waste collection) • Tire collection • Trying to divert construction and demolition materials from landfills • Through Waste Auditing have tracked the amount and composition of Residual Waste in Lansdowne • Material placed in the landfill is spread and then compacted to minimize the space taken • Covering is not completed daily • Amnesty cards accepted • Burns brush at landfill site (looking for ways to eliminate this process) • Proposing a Reuse Depot → Annex C • Currently diverts 53% of MSW to recycling → the goal is 60%
Strategic Waste Management Plan Initiatives	• Local Policy • Funding • Participation • Effectiveness	• Waste Recycling Strategy was funded by Waste Diversion Ontario's Continuous Improvement Fund • Implemented Blue Box program • Curbside pick-up is in place • Blue bin and garbage pick-up are brought to the Salem and Bradshaw landfill site • Are not considering the need for an organic waste disposal strategy • Waste exchange website → encourages reusing • Currently have to pay for bag tags for curbside pickup however would like to implement a 2 bag limit as well • Want to enhance the condition of recycling depots (landfills) → not very well maintained • Want to encourage small businesses to become accountable for their consumers waste • Currently processes recyclables at the Kingston MRF (KARC) • Methane emissions reduction goals • Controlling Leaching rainwater that is emerging from landfill sites • Education at the forefront of waste diversion improvement	• Waste Audits conducted annually through "The Green Squad", full report conducted in 2009 • "Zero Waste Policy", striving to divert all or most waste from landfills • Educational implementations • Extended Producer Responsibility, encouraging businesses to take responsibility for the waste that their products produce • Initiating curbside pick-up → not in place in Ward 2 or 3 • Aim to increase the variety of items at landfills in order to produce a higher rate of recycling • Think it would be beneficial to coordinate with other municipalities to construct an overarching recycling and garbage collection strategy • Has made diversion of organic waste a high priority • Have conducted a cost-efficiency analysis of energy utilization through biogas and thermal reduction implementation • Municipality's solid waste, disposed of in landfills, occupies 3, 278 cubic meters of space per year • Pursuing federal funding: the Green Municipal Fund and the Continuous Improvement Fund • Resource library has been formulated in order to keep track of data hence forth • Methane emissions reduction goals • Controlling Leaching rainwater that is emerging from landfill sites
Waste Technology at Landfills	• Machinery • Bag Tags • Clear Bag Usage	• Does not require clear bags • Bag tags are required	• If operating out of only WARD 1, could have a more efficient compactor and shredder • Does not currently own a shredder • Clear bags and bag tags are in effect • Currently have adequate separation bins, however has indicated room for improvement • Organic/compost waste disposal program in effect at landfills

16.4.3 ArcGIS Landfill Map (Screenshot)



16.5 Ethics Form

Consent Form for Interviews with Professionals (Expert interviews)
or Public Officials (Person holding Public Office/position in government)

Assessment of solid waste management in the Frontenac Arch Biosphere Reserve
School of Environmental Studies, Queen's University

Course project research for ENSC 430 – Hon. Project in Environmental Sustainability (Fall 2011)

Name (please print clearly): _____

1. I have read the Letter of Information and have had any questions answered to my satisfaction. I understand that I will be participating in research for the project courses ENSC 430 – Hon. Project Course in Environmental Sustainability for fall 2010 Assessment of Solid Waste Management in the Frontenac Arch Biosphere Reserve at the Queen's School of Environmental Studies.

2. I understand that this means that I will be asked to participate in an interview. In understand that this activity will take *[insert duration of interview in number of hours or minutes]* of my time. I understand that I am being interviewed in my professional capacity as a *[insert profession and title; e.g., Parks Planner, Parks Canada]*. In addition to informing the outcome of this project course, my involvement will assist the student researchers to write a professional quality report.

3. I understand that my participation in this study is voluntary and I may withdraw at any time. I understand that although I am being interviewed in my professional capacity, that my confidentiality will be protected.

4. I understand that every effort will be made to maintain the confidentiality of the raw data now and in the future. I understand that the data, in its final form, may be published in a report or journal, or presented at academic or professional planning conferences, but any such presentations will be of general findings.

5. I am aware that if I have any questions, concerns, or complaints regarding my participation in the study, I may contact Dr. Graham Whitelaw, graham.whitelaw@queensu.ca (613-533-6000 ext 77379); or the Chair of the General Research Ethics Board (613-533-6081) at Queen's University.

16.5 Ethics Form Continued

6. I am aware that if I have any questions, concerns, or complaints regarding ethics with respect to this research, I may contact Dr. Graham Whitelaw, graham.whitelaw@queensu.ca (613-533-6000 ext 77379); or the Chair of the General Research Ethics Board (613-533-6081) at Queen's University.

I have read the above statements and freely consent to participate in this research:

Signature:_____ Date: _____