City of Stratford
GHG Inventory and Community Energy Plan

Prepared for

City of Stratford

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1. Introduction

1.1 Purpose

The purpose of the City of Stratford (City) Community Energy Plan (CEP) is to develop a framework for the City to understand the historical impact of its operations on greenhouse gas (GHG) emissions, and to take action by setting GHG reduction targets.

The first objective of this report was the development of a Community Energy Plan that addressed the facets of energy consumption in the community, for both city corporate and community based assets. This included the development of a GHG emissions inventory; benchmarking the City of Stratford's existing municipal energy intensity performance relative to other jurisdictions; identifying potential energy efficiency projects; and, establishing a GHG emissions reduction target.

1.2 Project Background

In 1993, a citizen group presented Stratford City Council with the *Roundtable for the Environment Report*, which became the City's guiding document for environmental decision making. In 2004, a new citizen's group established by Stratford City Council, completed a report card on the city's environmental accomplishments (since 1993) and prepared a new environmental plan. One of the recommendations of the report card was for the City to adopt the Federation of Canadian Municipalities' (FCM) Statement of environmental policies, and to work toward completing the five milestones of the Partners for Climate Protection (PCP).

In order to adapt a holistic approach to improved environmental performance, as well as to recognize the growing concern of global climate change, and Canada's commitment to the Kyoto Protocol, the City Council committed its intent to participate in the Federation of Canadian Municipalities Partners for Climate Protection, through a resolution dated March 8, 2004. Prior to this decision, Stratford had a long history of environmental commitment, being one of the first communities to initiate the blue box program, and in turn, pursuing an aggressive waste management program. The City also sought to manage the shores and waters of Lake Victoria/Avon River which run through the City.

1.2.1 GHG Emissions

Concern over the increasing trend in global warming and the degradation of air quality in urban areas has resulted in an international focus on the reduction of GHG emissions worldwide. Greenhouse gases include a variety of compounds, including water vapour; however, the Kyoto Protocol has focused on six leading contributors that include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6). As sunlight passes through the atmosphere and heats the Earth's surface, some of the energy is reflected back into the atmosphere as thermal radiation. Greenhouse gases trap this energy, which increases the atmospheric temperature creating a "greenhouse" effect.

The concern is that increased atmospheric concentrations of greenhouse gases are gradually increase the atmospheric temperature beyond historic levels, which could disrupt natural systems and human activities. Since the early 20th century, atmospheric CO_2 concentrations have increased by approximately 30 percent, believed to be the result of human activities from the industrial revolution to present day.

1.2.2 PCP Campaign

PCP is a partnership between the FCM and the International Council for Local Environmental Initiatives (ICLEI) - the international environmental agency for local governments. FCM is the lead partner on policy development, government relations and funding in Canada, and the ICLEI provides technical support.

By participating in the PCP the City of Stratford committed to five milestones[1]:

- **Milestone One: Take Stock** - Complete a greenhouse gas inventory and forecast. PCP provides free software to measure energy use and emissions for both municipal operations and the community. Use 1994 or the year with the best available data for the base year; forecast energy use and emissions for the next 10 or 20 years for municipal operations and the community. In the case of Stratford, the year with the best available data is 2003 which is used for the base year.
- **Milestone Two: Set a Reduction Target -**Establish a reduction target. Preferred targets are 20 per cent reduction in greenhouse gas emissions from municipal operations, and a minimum six per cent reduction for the community from base year levels, both within 10 years of joining PCP. The City of Stratford joined PCP in 2004, thus the reductions should occur before 2014.
- **Milestone Three: Develop a Local Action Plan -** Develop and finalize a local action plan that aims to reduce emissions and energy use in municipal operations and the community. This local action plan will incorporate public awareness and education programs.
- **Milestone Four: Implement the Plan -** Create strong collaboration between municipal government and community partners to carry through on commitments and maximize benefits from greenhouse gas reductions.
- **Milestone Five: Measure Progress -** Maintain support by monitoring, verifying and reporting greenhouse gas reductions.

In 2006, the City retained CH2M HILL to assist in the completion of Milestones 1, 2, and 3.

As of August, 2002, PCP had recruited over 95 local governments into its campaign. As a result of the City of Stratford's participation, they received a grant from the FCM to develop the CEP, which garnered additional financial support from the Province of Ontario Climate Change Secretariat, the Ontario Ministry of the Environment, and Union Gas.

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[1] FCM Partners for Climate Protection http://www.fcm.ca/scep/support/PCP/pcp_milestones.htm

1.3 Project Approach

The City of Stratford engaged CH2M HILL to develop the Community Energy Plan. This consisted of several phases of data collection and assessment for the following areas:

- GHG emissions inventory
- Benchmarking of Energy Efficiency
- Identification of Energy Reduction Projects

2. GHG Emissions Inventory

2.1 Methodology

An inventory of GHG emissions was developed for the City of Stratford using 2001, which is with the year with the most readily available data, as the base year. GHG emissions were estimated by examining energy use information (electricity, natural gas, etc.) and gasoline consumption for fleet vehicles. In some cases, historical data for 2001 was not available, and estimates of emissions were developed based on available information. Specific methodologies and assumptions for these calculations are discussed below. The source data was manipulated for input into the PCP Greenhouse Gas Emissions Microsoft Excel Spreadsheet[2], for calculating emissions in tonnes (Mg) of CO_2 equivalents (CO_2e) per year. The spreadsheet model estimates GHG emissions using U.S. E.P.A. and provincial electricity grid emission factors and data inputs such as:

- Energy consumption data (electricity, natural gas, diesel, etc,),
- Vehicle Kilometers Traveled (VKT),
- Solid waste production, and
- Emissions data for major emitters within the City of Stratford.

Tonnes of CO_2e is a measurement of the heat-trapping potential of the major greenhouse gases (CO_2, CH_4, N_2O, etc) using CO_2 as a basis for comparison. Each greenhouse gas has a global warming potential (GWP) which is a factor that represents the magnitude of the heat-trapping ability of a gas. Methane (CH_4) has a GWP of 21,[3] thus it traps twenty-one times more heat radiation than CO_2. Therefore, one tonne of CH_4 would be reported as 21 tonnes of CO_2e.

The spreadsheet model has two analysis modules. The "Community Analysis" module is used to estimate emissions in the community-at-large, and the "Corporate Analysis" module is used to estimate emissions from City-owned operations such as buildings and vehicle fleets.

The GHG inventory was developed for the base year of 2003 as that was the year with the best available data. Using local planning growth and development data, GHG emissions were forecasted for the target year of 2014 for the interim target of 20% reduction of base year within 10 years of joining the PCP, which the City joined in 2004.

Measures to reduce GHG emissions were identified and analyzed for their ability to meet the reduction target. City programs, policies, or projects planned or ongoing that may have the potential to reduce GHG emissions, were included as reduction measures for this analysis.

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[2] Inventory Spreadsheet Tool KN inventory spreadsheets.xls available athttp:\www. kn.fcm.ca/ev.php|Parteners for Climate Protection|Tools.

[3] The GWP is provided by the UN's Intergovernmental Panel on Climate Change (IPCC) for gases assessed over a 100-year time horizon. The IPCC published its Third Assessment Report (TAR) in 2001ammending the GWPs of several gases including methane. IPCC's Second Assessment report (SAR) in 1996 had previously reported the GWP of CH_4 as 21. As many national inventories have not yet adopted the TAR GWPs, the SAR values were used.

2.1.1 Community Analysis Data Collection

The Community modules required information inputs for the following categories:

- Residential
- Commercial/Industrial
- Transportation
- Solid Waste

Data for the community analysis included natural gas consumption rates, provided by Union Gas; electricity demand data from Festival Hydro and transportation data was derived from automatic traffic counts and road length data provided by the City. Solid waste data is tracked by the City based on placed tonnage in the landfill.

2.1.2 Corporate Analysis Data Collection

The Corporate modules required information inputs for the following categories:

- Buildings
- Water/Sewage
- Vehicle Fleet
- Solid Waste

Data for City facilities energy consumption such as electricity and natural gas was collected from Festival Hydro and Union Gas. Fuel purchases for fleet vehicles were a roll-up of data obtained from the various departments. Water and sewage data emissions were derived from electricity consumption, while waste data was derived from the waste container services tender for contract.

2.2 Community Emissions Inventory

Tables 2-1 to 2-4 contain energy CO_2e estimates from various sectors in the community. The apparent disproportional decrease of CO_2e (t) based on electricity usage between the 2001 and 2005 data is due to less energy production from coal, resulting in a decrease in the electricity emissions coefficient for Ontario electricity production between these years. The electricity emission coefficient represents the amount of emissions resulting from the generation of a given quantity of electricity. The coefficients are calculated annually by Environment Canada based on an average provincial electricity generation mix (the fuel sources used to generate electricity such as coal, natural gas, oil, nuclear, hydro, and renewable) and may change annually due to a number of factors such as fuel types, intra-provincial generation, inter-provincial inflows and imports from the United States. The coefficients decreased in 2004 and 2005, thus, an equivalent amount of electricity produced in 2003 created more emissions than the same amount of electricity production in 2004 and 2005.

TABLE 2.1
COMMUNITY ENERGY CO_2E ESTIMATES

2003 2005	Measure	CO_2e(t)	Measure	CO_2e(t)
Electricity (kWh)	441,243,895	120,460	434,651,163	95,623
Natural Gas (cum)	113,438,857	213,272	92,205,993	173,353
Energy Subtotal		**333,732**		**268,976**

TABLE 2.2
TRANSPORTATION CO_2E ESTIMATES*

	2005	
	VKT millions	CO_2e(t)
Collectors/Local Roads	97,293,974	36,496
Transportation Subtotal		**36,496**

* These numbers were estimated from Vehicle Count and Road Length Data provided by City of Stratford Transportation. The VKT is taken as an average of data from 1985-2005; this average VKT is the same for years 2001 to 2005

TABLE 2.3
SOLID WASTE CO_2e ESTIMATES

	2003		2005	
	Measure (tonnes landfilled)	CO_2e(t)	Measure (tonnes landfilled)	CO_2e(t)
Solid Wastes	25,259	12,167	24,336	11,723
Solid Wastes Subtotal		**12,167**		**11,723**

TABLE 2.4
COMMUNITY EMISSIONS SUMMARY

	2003 CO_2e (t)	2005 CO_2e (t)
Energy	333,732	268,976
Transportation	36,496	36,496
Solid Waste	12,167	11,723
Community Total	**382,395**	**317,195**

[1] These numbers were estimated from Vehicle Count and Road Length Data provided by City of Stratford Transportation. The VKT is taken as an average of data from 1985-2005; this average VKT is the same for years 2001 to 2005

2.3 Corporate Emissions Inventory

The corporate emissions inventory is an estimate of GHG emissions from all City-owned facilities, including buildings, vehicles, and water and sewage facilities. For the base year of 2003, the GHG emissions totaled 6,606 tonnes of CO_2e for all municipal sources.

Table 2-5 presents the breakdown of GHG emissions by corporate sector. GHG emissions from City facilities with each of these sectors are presented in greater detail in the following sub-sections.

TABLE 2.5
GHG EMISSIONS BY CORPORATE SECTOR (IN TONNES)

	2003	2005
Buildings - Nat. Gas	1,079	981
Buildings - Electricity	2,100	1,700
Vehicle Fleet	1,103	1,181
Water/Sewage	2,141	1,856
Solid Waste	183	157
Corporate Total	**6,606**	**5,875**

2.4 Corporate Inventory Analysis

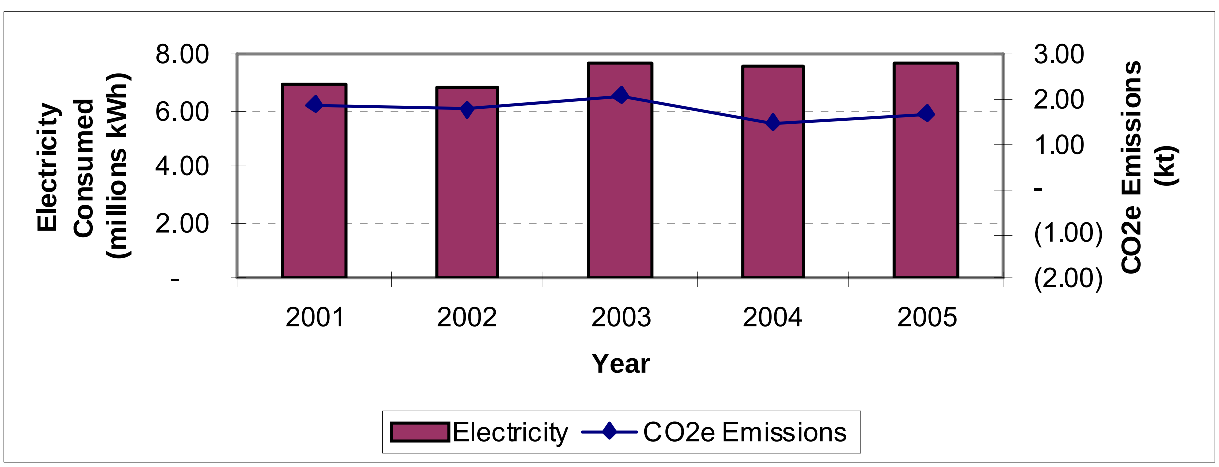
Buildings

The City's building facilities include all corporately run buildings, excluding buildings involved with wastewater and water activities. The City's buildings facilities represent a major percentage of the corporate emissions.

There was a significant increase of electricity use from 2001 to 2005; however, a subsequent increase in emissions does not occur. This reduction is due to a decrease in electricity emission coefficients in Ontario; though more electricity was consumed in 2005 than any year from 2001 to 2003, the resulting emission value is lower. The electricity usage by corporate buildings increased by 0.4% from 2003 levels, but the amount of emissions decreased by 19%.

Figure 2-1 illustrates the corporate buildings electricity use. Thus, the graph is an indication of electricity use based on the most complete data sets available at the time of the data collection for this report.

FIGURE 2-1
STRATFORD CORPORATE ELECTRICITY USE



The natural gas consumption and resulting emissions decreased by almost 10% from 2003 to 2005. Natural gas emissions account for more than 30% of all Corporate building emissions.

Fleet Vehicles

Departments within the City of Stratford operate and maintain their own fleet of vehicles. The fleets range in size and vehicle types according to the department operations.

The data set for 2003 is incomplete; the earliest year with the best set of data available is the year 2005. Looking at available data, there is significant increase in the consumption of unleaded gasoline between years 2001 and 2005; whereas there is a drop in propane use. The Transit department contributed the greatest amount of emissions.

Water and Wastewater Facilities

Stratford operates 20 facilities, which include a water treatment plant and sanitary and stormwater pumping stations, involved with waste and wastewater activities. There was an increase of 8% in electricity usage by water and wastewater facilities in 2005 from the 2003 levels. The consequent emissions decreased by 13% in 2005 from 2003. The decrease in emissions is due to the decrease in electricity emission coefficients in Ontario.

The electricity data provided not disaggregated for each facility but provide summarized by operations (water and wastewater). There was also incomplete data for the years 2000, 2001 and 2005; the emissions calculated is an estimate and should be used as a guideline for reduction targets. According to the available data, water facilities generate 1.5 times more emissions than wastewater facilities.

Landfill

The City of Stratford owns and operates The City of Stratford Landfill under the Ministry of Environment (MOE) Certificate of Approval No. A150101. The landfill receives residential waste, industrial, commercial and institutional (ICI) non-hazardous wastes generated within the City, demolition materials, street sweepings and dewatered sewage sludge from the City of Stratford Water Pollution Control Plant. The amount of overall corporate waste going to the landfill and the resulting emissions decreased from 2003 to 2005 by 14%.

3. Emissions Forecasts

3.1 Methodology

The current inventory covers years from 2001 to 2005. Forecasting the amount of emissions that would occur ten and twenty years after Stratford joined PCP is necessary to assess the scope of reductions Stratford has to make to reduce emissions from the base year levels. The years of interest are 2014 and 2024.

The emissions forecasts for each of the Corporate and Community categories were extrapolated from 2005 data based on population growth estimates. 2014 and 2024 business-as-usual (BAU) GHG emissions, which represent the emissions that would be expected to occur in the absence of any GHG reductions actions.

The 2014 and 2024 business-as-usual emissions from electricity and natural gas consumption are based on the assumption that usage growth rate is proportional to the population growth rate. For forecasted electricity emissions calculations, it assumes no change in the electricity generation mix occurs after 2005; thus the electricity emission factor is used to calculate emissions.

GHG emissions in 2014 and 2024 from the transportation sector are expected to increase from 2005 levels. However, due to the lack of information available, a projection of the emissions could not be estimated. For the purpose of calculating emissions for 2014 and 2024, it is assumed that the vehicles kilometers traveled (VKT) is constant from the year 2005. The value was calculated as an average from data provided from 1985 to 2005; in the inventory, this calculated value was used to estimate emissions for all years included in the inventory. This forecast also assumes no change in vehicle fleet mix over time.

The forecasted BAU emissions in 2014 and 2024 for landfills assumed that 25,000 tonnes of solid wastes are to be landfilled annually from the year 2006 and onward. This amount is an estimate from an extrapolation from waste data landfilled and was used to calculate the amount of landfill gases emitted from the Stratford landfill.

3.2 Projections

Table 3-1 summarizes the population growth and projected growth the years 2014 and 2024. Table 3-2 provides emissions data relevant to the inventory (years 2001 to 2005).

TABLE 3.1
MEASURES OF GROWTH RATES FOR THE CITY OF STRATFORD

	2001	2003	2005	2014	2024
Population	29,780[1]	30,052[2]	30,597[2]	32,081[3]	34,059[3]
Transportation VKT [4]	97,293,973	97,293,973	97,293,973	97,293,973	97,293,973
Community Waste Landfilled (t)	25,657	25,259	24,661	25,000[5]	25,000[5]

1 – Statistics Canada 2001 Census
2 – Linear interpolation based on data for year 2001 and 2006 provided by Statistic Canada
3 – Linear interpolation based on information provided by City of Stratford (assumed annual growth rate of 0.6% from 2006-2008 and 0.8 from 2008 and onward)
4 – Estimate from Vehicle Counts and Road Lengths data for years 1985-2005 provided by City of Stratford
5 – Based on assumption that the landfill will receive 25,000 tonnes of wastes annually from 2006 to 2024. Community wastes landfill does not include waste generated by Corporate accounts.

TABLE 3.2
GHG EMISSIONS (TONNES CO_2E) FROM THE CITY OF STRATFORD

	2001	2002	2003	2004	2005
Community Total[1]	154,122[2]	149,282[2]	382,395	334,398	317,195
Corporate Total	5,860[2]	4,313[2]	6,606	5,641	5,874

1 – Community transportation data (VKT) was assumed to be the same from 2001 to 2005. VKT for individual years could not be calculated due to unavailable data.
2 – Natural Gas data was not available for 2001 and 2002; subsequent emissions are not included in the inventory

Based on the current inventory and growth rates, the equivalent increase in GHG emissions are summarized in Table 3-3.

TABLE 3.3
FORECASTED GHG EMISSIONS FOR 2014 AND 2024

	2014	2024
Community Total (tonnes CO_2e)	334,090	351,693
Corporate Total (tonnes CO_2e)	6,985	8,340

3.3 Target Year Emissions

Stratford has committed to reducing emissions by 6% and 20% reduction for Community and Corporate emissions levels, respectively, from 2003 levels within a ten year period of joining PCP. 2003 is the earliest year with the best available data which established it as the baseline year. The City of Stratford needs to target annual emission reductions to 5.3 kt CO_2e as a Corporation, and 359.4 kt CO_2e in the Community by 2014. The amount of 2005 Community emissions have exceeded the 6% PCP reduction target from 2003 values; this reduction amount can be accounted by the decrease in landfill wastes, natural gas usage and lower electricity emission coefficients in 2005 than 2003. According to the BAU forecast, the projected 2014 emissions would exceed the PCP Community goal by 25.4 kt CO_2e, but would require a reduction of 1.9 kt CO_2e a from 2003 values to meet the PCP reduction of 20%.

4. The Corporate Inventory and Plan

4.1 Methodology

The *Corporate Inventory and Plan* will evaluate Stratford's municipal operations by looking at the energy efficiency of end-use equipment in City facilities, as well as the potential for improving operational practices to reduce energy use. Integral to the Corporate Plan will be an Environmental Accounting of how the City can improve its energy use monitoring, and provide direct rewards to departments that develop innovative solutions for reducing energy use. Motivating the staff to develop their own innovative ideas will be a key part of the plan.

The major components of the Corporate Plan will include:

Office Buildings	Landfill	Water & Wastewater	Fleet

Development of a List of Energy Efficiency Measures for the City to Implement

Equipment Based Measures	System Based Measures
► Improved Efficiency	► Reduced System Demand (water conservation, waste minimization)
► Improved Controls	► Implementation System for Inefficiencies to be Reported
► Reduced Operations	► Identify Alternate System to Meet Same Objectives
► Alternative Equipment Technology	► Implement Monitoring & Targeting Programs
	► Establish Energy Use Accountability
	► Create Reward Incentives for Energy Efficiency (EE)
	► Integrate EE Targets Into Corporate Business Plan
	► Implement a centralized database to foster a more efficient data collection process and a means to monitor energy consumption

It is intended that Corporate successes will allow the City to "lead by example" in its efforts to encourage community participation. A first step in assessing the corporate assets is to develop an equipment database for the following purposes:

- To log the energy consuming equipment in each of the corporate buildings
- To identify the nature and age of equipment, and
- To assess individual pieces of equipment for their energy efficiency.

Such a database would aid in the review of the operations and serve as a centralized location to gather information on the energy systems and demands for various sites. The data from the database can easily be extrapolated for analysis and comparison and used to generate energy efficiency reports.

4.2 Corporate Assets

The following tables (Table 4-1 to Table 4-4) summarize the corporate assets pertinent to the GHG emissions based on the four modules developed for the inventory including:

- Building Facilities
- Landfill/Waste
- Water and Wastewater facilities
- Vehicle Fleets

TABLE 4.1
BUILDING FACILITIES

Facility	Area m^2	Date Built	Hours of Operation	Operational Profile
City Hall, Justice Building, and other Administration Buildings	Not Provided	Not Provided	5 days/week, 8am to 5pm Weekends: 7am to 4pm	Offices, Meeting Rooms, Council Chambers, Administrative functions
Public Library	2695	1903	6 days/week, 10am to 9pm Sunday: 12pm to 5pm	Offices, Public reading areas
Public Housing	Not Provided	Not Provided	7 days/week, 24 hours a day	Houses and Apartments
Anne Hathaway Day Care Centre	495	1967	Monday to Saturday 6:30am to 5:30 pm	Childcare Facility
Fire Station #1	536	1968	7 days/week, 24 hours a day	Offices/Living Rooms, Apparatus
Fire Station #2	364	1979	7 days/week, 24 hours a day	Offices/Living Rooms, Apparatus
Community Facilities	Not Provided	Not Provided	Not Available	Not Available
Stratford Airport	Not Available	1991	Not Available	Not Available
Public Works Garage	948	1977	7 days/week, 24 hours a day	Garage, Stockroom, Offices
Traffic/sewer Building	438	1950	7 days/week, 24 hours a day	Garage, Stockroom, Offices

TABLES 4.2
LANDFILL PROFILE

Location	Operational Profile	Building History
777 Romeo Street South	Weigh scale kiosk	Built in 1990

TABLE 4.3
WATER SYSTEM FACILITY NAME, ADDRESS, AND FUNCTION CATEGORY

Facility Name	Address	Function
Stratford Sewage Treatment Plant	701 Gore St. W.	Sewage Treatment Plant
Dufferin Street Water Tower	221 Dufferin St.	Reservoir
Forman Avenue Water Tower	430 Forman Ave.	Reservoir
Chestnut Street Well	NA	Reservoir
Mornington Street Well	637 Mornington St.	Reservoir
Dunn Well Road Well	100 Dunn Road	Reservoir
Lorne Avenue Well	500 Lorne Ave. W.	Reservoir
Cooper Street Well	161 Wellington St.	Reservoir
O’Loane Avenue Well	947 O’Loane Ave.	Reservoir
Water Supply Control Station	39 Romeo St.	Reservoir
Vivian Pump Station	360 Romeo St. S.	Sanitary Pumping Station
Devon Street Pump Station	NA	Sanitary Pumping Station
Douro Pump Station	NA	Sanitary Pumping Station
Romeo Street Stormwater Pump Station	NA	Stormwater Pumping Station
Burritt Street Pump Station	NA	Sanitary Pumping Station
Dunn Street Pump Station	NA	Sanitary Pumping Station
Taylor Pump Station	NA	Sanitary Pumping Station
Vic Inn Pump Station	NA	Sanitary Pumping Station
Lorne Avenue Station	NA	Sanitary Pumping Station
Downie Station	NA	Sanitary Pumping Station

TABLE 4.4
FLEET VEHICLES

Fleet by Department	Number of Vehicles
Engineering & Public Works	44
Community Services	26
Transit	20
Fire	14
Police	18
Other	5

4.3 Corporate System Modules Summaries

The following sections highlight the findings of the module analysis of the Corporate assets. Each of the modules is appended to this report.

4.3.1 Buildings Summary

In 2005, the City's recreation facilities consumed 7,726 MWh of electricity and 521,780 m^3 of natural gas. This resulted in 1700 and 981 tonnes CO_2e of GHG emissions, respectively. To meet the 20% PCP reduction target for this sector, a total reduction of 164 tonnes CO_2e from 2005 levels must be achieved.

TABLE 4.5
SUMMARY OF CORPORATE BUILDINGS EMISSIONS (IN TONNES CO_2e)

2005 GHG Emissions	2,681
PCP 20% Reduction Target from 2003 Emissions	2,544

Additional specific GHG reduction opportunities and details are provided in the Buildings Module in Appendix A.

4.3.2 Landfill/Solid Waste Summary

For the GHG emissions inventory, the emissions are determined from the total waste landfilled in a year. In 2005, the City of Stratford landfilled 24,661 tonnes of solid waste materials, 977 tonnes less than the amount of wastes entering the landfill in 2003. The City of Stratford has steadily increased the amount of recyclables that have been diverted from disposal in the landfill through the implementation of new initiatives. The amount of city-wide GHG emissions produced in 2005 is 11,879 tonnes CO_2e.

The amount of Corporate wastes landfilled in 2005 was 325 tonnes, which accounted for 1.3% of all landfilled wastes.

To meet the 20% PCP reduction target for this sector, a total reduction of 10 tonnes CO_2e from 2005 Corporate waste levels must be achieved. A total of 1,999

Further GHG reductions can be obtained by increasing the waste diversion rate, which currently stands at 65%.

TABLE 4.6
SUMMARY OF CORPORATE WASTES (IN TONNES CO_2e)

2005 GHG Emissions	157
PCP 20% Reduction Target from 2003 Emissions	**146**

TABLE 4.7
SUMMARY OF CITY-WIDE WASTE (ALL LANDFILLED WASTES) EMISSIONS

2005 GHG Emissions	11,879
PCP 20% Reduction Target from 2003 Emissions	**9,880**

Additional specific opportunities and details are provided in the Landfill/Waste Module in Appendix B.

4.3.3 Water/Wastewater Summary

In 2005, the Water and Wastewater facilities **consumed 8,436 MWh of electricity** which resulted in 1,856 tonnes CO_2e of GHG emissions. Water facilities account for 60% of the total Water/Wastewater facilities' emissions. To meet the 20% PCP reduction target for this sector, a total reduction of 143 tonnes CO_2e from 2005 levels must be achieved.

TABLE 4.8
SUMMARY OF WATER/WASTEWATER EMISSIONS (IN TONNES CO_2E)

2005 GHG Emissions	1,856
PCP 20% Reduction Target from 2003 Emissions	**1,713**

Additional specific opportunities and details are provided in the Water/Wastewater Facilities Module in Appendix C.

4.3.4 Fleets Summary

Departments within the City of Stratford operate and maintain their own fleet of vehicles. Due to the different purposes of department fleets, departments run independently from one another with no standardized City wide system of operation. Fuel supply is tendered and managed by the City. The fleets range in size and vehicle types according to the department operations. In 2005, 440,056 L of fuel, which includes diesel, unleaded gasoline and propane, was consumed by all Corporate fleets; diesel accounted for 91% of the fuel consumed. The resulting emissions from fuel consumption were 1,181 tonnes CO_2e. The Transit department was the major emitter, contributing 69% percent of the emissions. To meet the 20% reduction target for the corporate assets within the fleets a reduction of 299 tonnes CO_2e would be required from 2005 emission levels.

TABLE 4.4
SUMMARY OF FLEET EMISSIONS (IN TONNES CO_2E)

2005 GHG Emissions	1,181
PCP 20% Reduction Target of 2003 Emissions	**882**

Additional specific opportunities and details are provided in the Fleets Module in Appendix D.

4.3.5 Analysis of Potential Reduction Targets

Table 4-11 summarizes the total GHG emission reduction measures and identifies the remaining gap.

TABLE 4.50
SUMMARY OF COPORATE REDUCTION TARGET

Corporate Asset Class	Reduction Target - 20% from 2003 levels (tonnes CO_2e)	Required Reductions from 2005 to Meet Target (in tonnes CO_2e)
Corporate Buildings	2,544	137
Waste/Landfill	9880	1999
Water / Wastewater	1713	143
Fleet Vehicles	882	299
Grand Total CO_2e Emission Reduction Potential	**15,019**	**2,578**

The reductions necessary to achieve the PCP 20% reduction target are presented in the above Sections and in the Appendices within each asset class. Table 4-11 demonstrates that the 20% reduction could be achieved for all asset classes by addressing the landfill gas emissions. Stratford's landfill does not currently have a landfill gas collection system in place. Landfill gas is composed primarily of methane, carbon dioxide, and trace organic compounds. It is produced by the decomposition of waste and is estimated to contribute up to three per cent of Canada's GHG emissions. Flaring destroys the methane in landfill gas, and therefore, reduces the GHGs. Utilization, instead of flaring, provides additional benefits, including generating revenue at sites where landfill gas utilization is economically viable. The capture of landfill gas provides a source of renewable energy, primarily for heating and generating electricity, but also for new uses such as vehicle fuel.

5. The Community Energy Plan

This section of the report focuses on the steps required to develop a Community Energy Plan. The following text will outline key issues and strategies for developing the plan.

The ***Community Plan*** would lay out a strategy for engaging all citizens and business sectors to participate in improving their energy use requirements. This section of the plan will explore new alternatives to not only encourage local businesses to become more energy efficient, but also to become "champions" in providing economically desirable green product options to the community. The underlying premise of the Community Plan is that sustainable improvements must be founded in natural market economics as opposed to solely relying on incentive and public awareness programs. By fostering increased trade and manufacture in the growing world green economy, the City will prosper through a cleaner environment and stronger economy.

The Green Economy is just starting to gain strong momentum across the country as municipalities set green purchasing policies. Failing to assist the local businesses in supplying this market demand will suggest a significant missed market opportunity.

The major components of the Community Plan will include:

1. Identification of local companies providing green products and services.
2. Understanding the Green Product Economy and how the City can assist local businesses to utilize this emerging market.
3. Develop Government/Industry stakeholder groups and suggest strategies to work cooperatively to synergistically meet business and environmental objectives.
4. Gain full engagement of the Community through sector based Stakeholder Groups.

5.1 Overview of Current Initiatives and Lessons Learned

The City of Stratford has not been highly proactive in adopting programs and partnering with energy utilities to bring energy efficiency programs to our community. Stratford needs to implement several sustainable community based incentive program where consumer buying practices revert back to original patterns once government subsides cease. Incentive programs need to serve two purposes: raise public awareness of energy efficiency and be a long-term strategy. While incentive programs do have value in raising public awareness of energy efficiency, it is clear that a sustainable long-term strategy must be non-incentive based and consumer driven.

5.2 Defining the Challenges

In general, there are three mechanisms to encourage non-incentive based energy efficiency within the community:

1. Improve Energy Efficiency of Equipment Sold in Marketplace (New & Retrofit)
2. Education – Change Behavioral Factors Influencing Direct/Indirect Energy Use
3. Regulate energy efficiency/ energy use

To develop new strategies, many municipalities have focused on education/awareness and, in some instances, regulations, to encourage energy efficiency. To evaluate the potential success of any new energy efficiency strategy, it must be considered in the context of technical, economic, societal, and political challenges.

Analyzing the Success of Energy Efficiency Measures

Energy Efficiency Strategy	**Technical**	**Economic**	**Societal**	**Political**
Education/ Awareness	Manageable	**Difficult**	Good	Good
Regulation Command & Control	Manageable	Manageable	**Difficult**	**Difficult**
Consumer/ Market Driven	Manageable	Good	Good	Good

For example, a strong education/awareness program of energy efficient technologies would likely receive strong societal and political support because everyone wants to feel green, but this may not always actively influence purchase decisions where higher efficiency translates into higher capital cost. On the other hand, regulations can definitely overcome economic hurdles, but often there is a lack of political will to impose unpopular regulations.

Strategies that can positively affect market demand usually have the highest success rate and greatest sustainability. When consumer demand for a green product exists, there is likely a lack of societal or political hurdles, and competition in the marketplace will usually overcome any technical or economic hurdles. The challenge then, becomes fostering a business environment in Stratford where green industry can flourish meeting new market demands.

5.2.1 Sample Energy Efficiency Initiatives

Here are some sample initiatives that the City might look to, which fall under the different types of mechanisms discussed previously:

Education/Awareness Sample Initiatives

Encourage Bicycling/Walking

The City of Stratford could develop more trails, lanes, paths, and walkways throughout the community to provide additional transportation options. This could include secure and weather-protected bicycled racks at major travel destinations, and an extensive sidewalk system in urban corridors and compact neighborhoods that are pedestrian-friendly, with amenities such as shaded areas, benches, water fountains, and landscaped walkways. The City of Stratford could also allow for the accommodation of bicycles on transit buses and shuttles with the use of bicycle racks. The City could also encourage businesses to provide showers to enhance "commuter bicycling."

Bicycling and walking are pollution-free and should be promoted as an alternative to other forms of transportation.

Carpooling and Vanpooling

The City of Stratford should encourage the public to carpool and vanpool. The City could petition the Ontario MOT for the development of HOV on major arteries and roads, serving to encourage car/vanpooling as an efficient transportation alternative. The City could encourage employers to provide preferential parking for carpool and vanpooling employees. The City could provide free parking for car/vanpools in the downtown area.

Telecommuting

The City of Stratford should encourage the business community to utilize alternative work schedules and reduce the number of commuter trips. With advances in computers and telecommunications, employees could telecommute from their homes (i.e. work from their home using home computer or laptop), or from regional telecommute centers.

Promotion of Energy Efficiency Programs

The City of Stratford should promote increasing the energy efficiency of existing and newly constructed buildings using other models, such as the "Green Buildings" program. The "Green Buildings" program focuses on sustainable building techniques which aim to minimize need for, and reliance on, energy and water supplies. There are many approaches that have been used to accomplish this, including but not limited to:

- Setting local building energy standards by modifying or developing City ordinances
- Requiring building permit applicants to outline energy efficiency measures, or document an energy efficiency plan
- Provide tax incentives to businesses, industries, and institutions that utilize energy-efficient appliances and technologies in new construction, or in upgrades

Promotion of renewable energy systems can also be made through a different program.

Regulation Command and Control Sample Initiative

Decrease Idling of Motor Vehicles

Traffic congestion causes excessive vehicle idling in traffic jams and at stoplights. Drive-through windows at restaurants and banks also encourage excessive vehicle idling, since this "convenience" does not often save time. The average passenger vehicle emits 1 kg of GHG per minute during summer conditions. This number is higher in cold weather and among poorly maintained vehicles. Excessive vehicle idling can be reduced by improving the existing road system, thereby encouraging efficient traffic flow patterns. This will tend to decrease travel times, reduce driver frustration, increase worker productivity, and potentially reduce traffic accidents caused by anxious and careless drivers.

Intelligent Traffic System

Another option for potentially reducing vehicle idling times is to install an Intelligent Traffic System (ITS) to improve traffic flow on the major roads and arteries, especially after traffic incidents. If the average idling time per vehicle could be reduced by at least 1 minute per day on major roads and arteries, then GHG emissions could be significantly reduced during the 20 year commitment period.

Staggered Work Hours

Traffic congestion during peak rush hour traffic contributes much of the GHG emissions from motor vehicles. With increasing growth and the common use of single-occupancy vehicles, travel times are increasing every year, especially as congestion worsens. One option for reducing peak congestion is to encourage employers to utilize staggered work schedules to minimize peak hour traffic. Employers could stagger work schedules such that half of its work force (1^{st} shift) would work from 7:00am to 4:00pm and the other half would work 9:00am to 6:00pm. To some extent, this has been implemented by many industrial companies, but there is the potential to expand this program further throughout the City.

Assuming that average travel times could be reduced by 1 minute per day, per vehicle by expanding the use of staggered work schedules, then, the potential GHG emissions reduction would be similar to reductions from minimizing idling.

Landscape Control

The City should strengthen its landscaping ordinance to encourage well-designed landscaping and tree planting, helping to reduce the amount of reflective heat from parking lots and to shade structures, which should also help to reduce cooling costs. The City could encourage existing developments and require new developments to consider the "Heat Island" effect during design, to leave more trees undisturbed and plan new landscaping to maximize the benefits of plants. Plants act as carbon sinks and can reduce building cooling costs through direct shading and through evapotranspiration, which tends to lower nearby air temperatures. Permeable geotextiles provide an alternative to paved areas. These materials provide the structural stability needed for vehicle access or parking, while reducing solar absorption. Using these permeable ground surfaces, interplanted with ground cover could enhance stormwater drainage and reduce atmospheric heating associated w/paved surfaces.

Consumer/Market Driven Sample Initiatives

Industrial Biodiesel Plant

Fostering the potential location of this type of facility in Stratford would have local economic and environmental benefits through the generation of lower GHG fuels.

Encourage Use of Alternative Fuel Vehicles

The City of Stratford should encourage the use of alternative fuel vehicles by providing refueling stations or encouraging the private sector to invest in alternative fueling stations. Vehicles powered by compressed natural gas (CNG) or electric vehicles have 50 to 80% fewer GHG emissions per mile than conventional gasoline-powered vehicles. Presently, this is a major hurdle as private industry partners are not favouring the supply of alternative fuel vehicles. The goal of this general measure is to reduce GHG emissions from vehicles by encouraging businesses, industries, and the general public to switch to alternative fuels that emit less GHG. It is difficult to project how market conditions, regulatory actions, and consumer response will affect the type of alternative fuel used in the future. Therefore, GHG emissions reductions based on the use of several alternative fuels is given below for comparison. Actual implementation of an alternative fuel program may result in one fuel being selected or a combination of fuels being selected.

Although the Provincial and Federal governments have typically been responsible for legislating and regulating the transportation sector, there are several options that the City can use for promoting the increased use of alternative fuels. The City of Stratford could encourage the use of alternative fuel vehicles by subsidizing the development of refueling stations throughout the City. Refueling stations should be owned by the private sector, but the City could provide grants for the construction of CNG refueling and electric recharging stations throughout the City. The City could also provide electric recharging stations at the City’s parking facilities. The City could promote the use of alternative fuel vehicles through public education and advertising campaigns. Another potential strategy would be to officially lobby or encourage the Province to enact requirements for businesses to purchase alternative fuel vehicles.

Residential Fuel Switching

The City of Stratford should encourage residents and builders to utilize cleaner fuels for home heating. The City could amend the local building code to restrict the use of heating oil. By 2021, many of the existing heating systems fueled by heating oil will reach the end of their useful life. The City could offer financial incentives, such as grants and low-interest loans, to encourage existing homes using heating oil to convert to a more efficient fuel. Many of these homes may be low-income households.

Improve Home Energy Efficiency

Improving the energy efficiency of homes as potential for large reductions in GHG emissions by reducing the demand for electricity generated by coal-fired power plants. There are many ways to increase energy efficiency and reduce waste during the design and construction phases of residential units, as well as after construction. Energy efficiency upgrades range from inexpensive retrofits, such as fluorescent lighting, to upgrades of existing HVAC systems. Also, solar technology has advanced in recent years and the cost of these systems continues to drop.

Energy Efficiency Improvements

Energy efficiency improvements can reduce energy demand by approximately 40%, compared to the average home. The following is a list of energy efficiency measures that could be implemented. The following section discusses energy efficiency measures that can be implemented in residential units.

Lighting

Lighting accounts for 15% of residential energy demand. The typical household spends $110 per year on lighting. Installing compact fluorescent lights (CFL) that utilize 50% less energy than incandescent lights can reduce energy costs. CFLs cost much more than incandescent lights, initially ($20-30). However, CFLs can last 10 times longer than incandescent bulbs and save approximately $45 in energy costs over the life of a 75 watt bulb.

Heating/Cooling

Proper design and installation of HVAC systems can reduce energy costs by 10 to 30% by ensuring properly sized equipment, reducing air leaks, and purchasing efficient systems. Improving the R-value of the insulation will also reduce energy demand. Purchasing or specifying high R-value windows will reduce drafts and condensation.

Appliances

The efficiency of major home appliances has increased considerably in recent years. The typical clothes washer consumes 40% more energy than models with newer technology. The EnerGuide program identifies appliances that meet certain energy efficiency guidelines.

Passive Solar Design

Utilizing passive solar design techniques in home construction can reduce energy costs up to 25% by ensuring proper window orientation. Roof overhangs and awnings can be used to minimize direct sunlight entering the home during the summer months. Most of the windows should face south to maximize home heating during the winter months. Proper design of landscaping can also reduce energy costs by shading the home and preventing direct sunlight to heat the home during the warmer months, but also allowing the winter sun to provide secondary heating. Light-colored roofs and attic vents can help reflect heat and cool the attic, which reduces cooling costs during the summer months. Also, designs to increase natural lighting in the home will reduce daytime demand for lighting.

Residential energy efficiency can be encouraged by the City through various strategies including:

- Amending local Building Codes for single-family and multi-family residential units to strengthen guidelines regarding insulation, HVAC systems, and appliances
- Encourage lenders to provide discount mortgage rates for energy efficient homes
- Time of sale energy efficiency requirement
- Offer rebates, low-interest loans, or other financing to retrofit existing low-income homes.
- Penalties, such as local tax, for less efficient equipment and appliances
- Expand Green Building program

Residential Use of Renewable Energy

Renewable energy systems provide the cleanest form of energy. Currently, photovoltaic (PV) or solar systems have high initial costs, but they typically last for 20 to 30 years and require no energy or fuels.

With advances in technology and programs, solar systems may become a more attractive option in the future for meeting residential energy demands. Power can be diverted from coal-fired power plants to a renewable energy with no GHG emissions.

Corporate Sample Initiatives

Expand Mass Transit System

This general reduction strategy is intended to reduce traffic congestion and GHG emissions by reducing the number of miles driven by single-occupancy, gasoline-powered vehicles. A specific measure identified to meet this goal is to include the expansion of the existing Bus Transit System in Stratford and ridership. The goal of this general reduction strategy is to reduce GHG emissions from the transportation sector.

Land Use Planning to Reduce VKTs

One of the most effective options for reducing GHG emissions from the transportation sector is to reduce trip times through effective land use planning. The City should develop policies to encourage high-density and mixed-use developments. The Plan also encourages infill development, especially in the downtown area, where the older industrial complexes are being converted to mixed-use developments with apartments and condominiums as well as retail stores.

High-density and mixed-use development can reduce GHG emissions by reducing the need for in-town driving. The purpose of these developments is to place residential areas closer to the commercial centers and reduce the number and length of trips for shopping and other errands. By some estimates, new development that improves accessibility by mixing land uses and clustering development generates about half as much VKT as does urban sprawl (Calthorpe, 1993: 43,64; Ewing, 1997:11).

While education and regulation can provide some success, by and large market driven strategies through partnering are the most successful and sustainable.

5.3 Sphere of Influence – Evaluating the Different Market Sectors

It is necessary to determine the factors and organizations that influence the purchase decision of energy consuming property and equipment. The following table gives an illustrative example, from various sectors.

TABLE 5.1
EXAMPLES OF COMMUNITY GHG EMISSION REDUCTION INITIATIVES

Market Sector	Example Product	Influencing Organizations	Example Issues
Residential	New Homes Home Renovations	New Home Builders Contractors Retailers	Building Codes Market Demand for R2000 Homes

TABLE 5.1
EXAMPLES OF COMMUNITY GHG EMISSION REDUCTION INITIATIVES

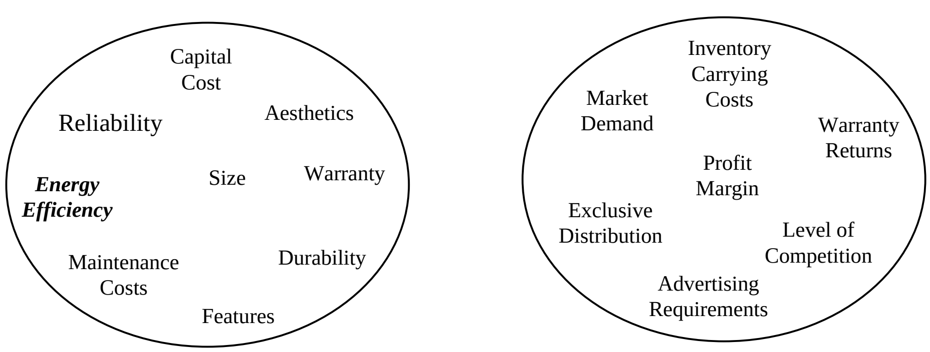
Market Sector	Example Product	Influencing Organizations	Example Issues
	Residential Appliances	Retailers Contractors	Ontario's Low Energy Cost Higher Capital Cost for EE Products Longer Payback for Seasonal Use Appliances Profit Margin for Seller
Commercial	Commercial Office Buildings	Developers Contractors	Building Codes Immediate Profit Motive for Developer – Developer Generally Not End-User Tenant Paying Energy Bills
Industrial	Heating/Cooling	Contractors Internal Staff	Major focus is placed on process operations Heating costs are often hidden
	Process Equipment	Process Equipment Manufactures Internal Staff	Product Quality / Productivity Dominates Decision Making Process Reliability Capital Investment Focused on Productivity Improvements that yield higher ROR

There is a product economy associated with each purchase decision and it will be important to understand the psychographics from both the seller's and purchaser's perspective.

A seller may be reluctant to promote an energy efficient product if it reduces market share or if it provides a lower profit margin. For example, in the commercial building market, the developer is rarely the end-user tenant responsible for paying the energy bills. Therefore, a lack of incentive is created for the developer to install energy efficient equipment and reduce profit margin.

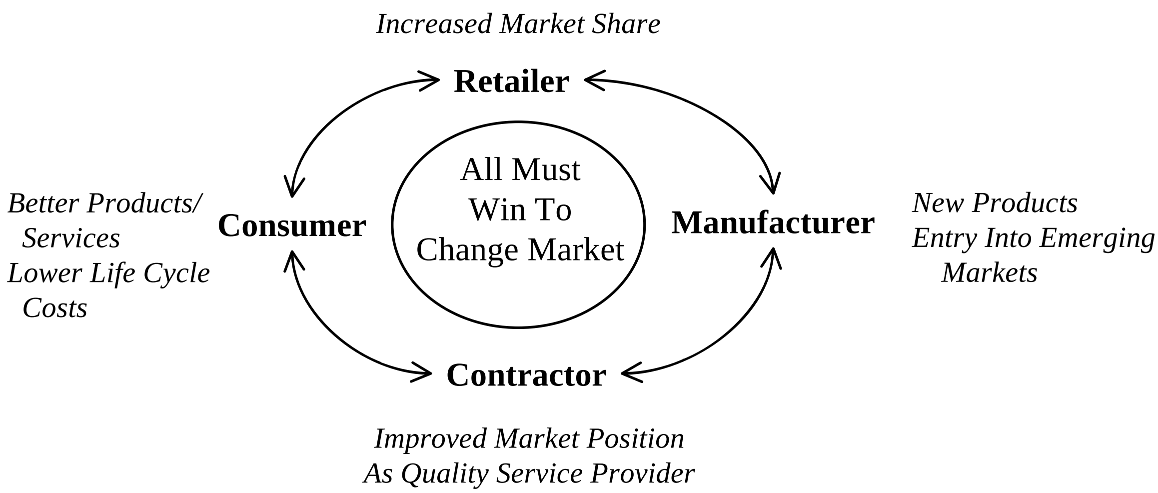
Product Economy

Purchaser's Perspective **Seller's Perspective**



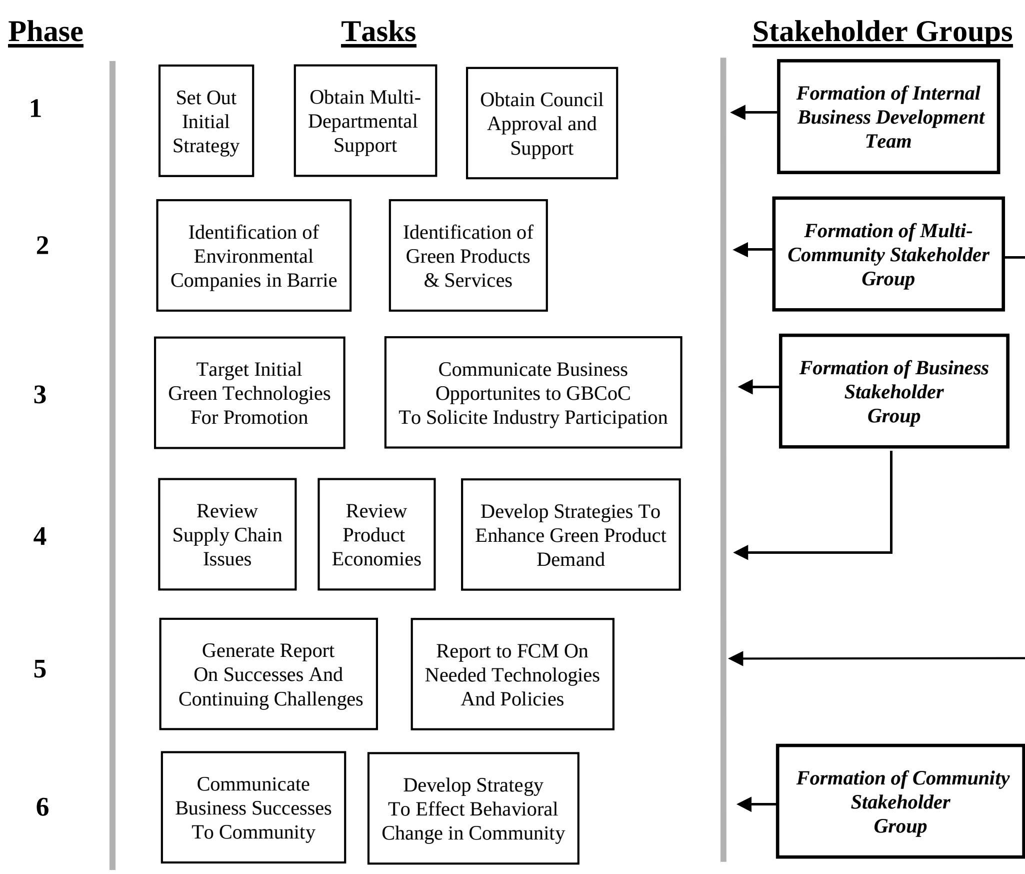
Energy Efficiency Will Always Be A Subset of the Product Economy

These types of market issues require long-term strategies and their understanding is crucial to developing a sustainable green economy. All participants in the product sales cycle must win.



5.3.1 Economic Development – Strategies for Enhancing Green Industry

The following chart and text provides an overview of our preliminary strategies to enhance a Green industry in Stratford.



Phase 1 – Establishing an Internal Business Development Team

Phase One will involve approval of the green business development strategy, as laid out in this document. Council approval and appropriate internal resource allocation will be critical, as management of the Stakeholder Groups will require team members from various City departments. As defined in subsequent sections, these will initially include, Engineering, Economic Development, Legal, and Public Relations.

Phase 1 Deliverables

1. Council Adoption of the Community Energy Plan Strategy
2. Initial Budget and Resource Allocation Given to Project
3. Creation of Internal Green Business Development Team

Phase 2 – Identification of Green Businesses in Stratford and Green Product Opportunities

To develop long term strategies and to create a foster green industry in Stratford, it will be necessary to identify the local companies that are currently providing green services and gain their feedback in identifying market hurdles that need to be overcome to foster greater success. Identification of companies could be managed through the Economic Development Office. These organizations are already proactive in lobbying member concerns relating to business development opportunities, so there would likely be strong interest in pursuing green initiatives.

Integral to this phase will also be the identification of green products that can help the city meet targeted environmental objectives. This task is a large undertaking and would be difficult for the city to undertake independently. Fortunately, the identification of economically viable green products is being pursued by other municipalities, under their Local Action Plan Initiatives and emerging Green Municipal Purchasing Policies. It will be our strategy to seek out these communities, through FCM, and create a Multi-Community Stakeholder Group for the purpose of identifying existing green products which will assist in community energy reduction.

Phase 2 Deliverables

1. Identification of environmentally focused businesses in Stratford.
2. Identification, through FCM, of municipalities fostering green product alliances.
3. Formation of Multi-Community Business Development Stakeholder Group
4. Creation of List Green of Business Opportunities

Phase 3 – Engage Local Business to Create Joint Green Business Development Strategies

The list of Green Business Opportunities developed in Phase 2 is intended to be the "carrot" to entice local businesses to join a Stratford Business Stakeholder Group. The second carrot will be the size of the market base represented by the communities comprising the Multi-Community Business Development Stakeholder Group formed in Phase 2.

The main purpose of this Phase will be to communicate the type of products, business potential, and market dynamics, of the emerging Green industry to local businesses. In addition, the potential impact of emerging market risks will also be conveyed. (Market risks would include factors, such as no longer qualifying as municipal supplier under Green purchasing policies being adopted by many jurisdictions.)

Phase 3 Deliverables

1. Formation of Stratford Green Business Development Stakeholder Group.
2. Presentations to local industry on the risks and opportunities presented by the Green Economy.
3. Develop list of target technologies to test business development model.

Phase 4 – Review of Selected Product Economies and Develop Marketing Strategies

Under this Phase, the Business Development Group will evaluate the product economies of key technologies that present opportunities for new business development and reduced energy consumption in Stratford. The information gained from evaluating product economies will be used to create cooperative strategies for the City of Stratford and local businesses to enhance market demand.

Phase 4 Deliverables

1. Report on How City and Local Businesses Can Enhance Market Demand for Key Technologies, Selected in Phase 3.
2. Implementation of Marketing Strategies

Phase 5 – Report Successes and Address Products That Have Significant Market Hurdles

It is likely that technologies will be identified in prior phases that would have a very positive impact on the environment, but currently they have significant market hurdles to achieve economic viability. It will be the objective of this phase to report on these technologies to FCM, and, through the stakeholder groups, provide recommendations that should be carried out a federal level to overcome the challenges.

Phase 5 Deliverables

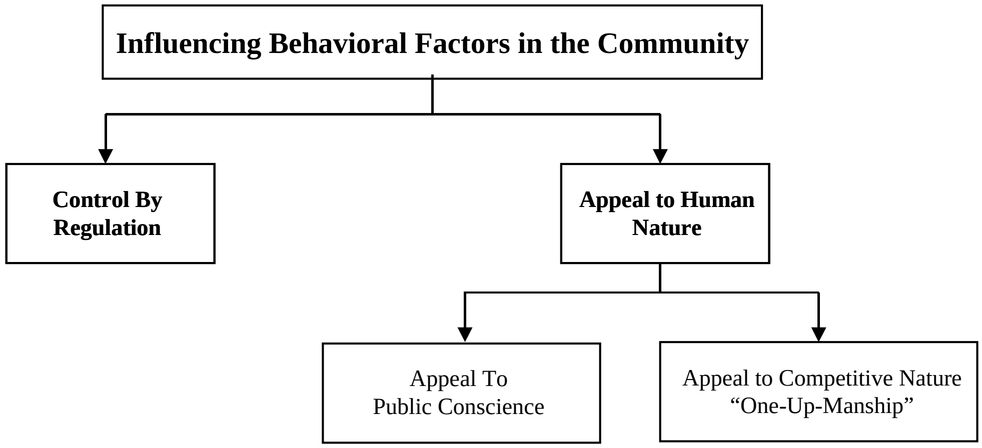
1. Report to FCM on Successes and Products that need broader based support to overcome market hurdles.

Phase 6 – Changing Behavioural Factors That Influence Energy Usage

Phase 6 is a departure from the business approach of the previous phases, and focuses more on influencing behavioural change within our community to reduce energy usage. This phase focuses more on the traditional approaches of education and outreach to communicate ways that individual citizens and organizations can reduce their environmental footprint.

The strategies developed under this task would be created by Community Based Stakeholder Group(s). A single group or multiple groups could be formed, representing each community sector. For example, residential, institutional, commercial, industrial.

The stakeholder groups would be tasked with identifying measures in each sector to improve overall energy efficiency and greening of the community. Each group would be asked to consider the use of regulations or an appeal to human nature. In the area of human nature, we would ask the group try to develop innovative approaches, leveraging more than just the environmental conscience. For example, energy benchmarking residential homes might suggest to wasteful homeowners that they are losing money.



Phase 6 Deliverables

1. Creation of Community Based Stakeholder Group(s)
2. Establishment of Communications Programs for Activities of Community Energy Plan
3. Development of community sector based strategies for encouraging energy use reduction.

6. Acknowledgements

CH2M HILL would like to acknowledge the following participants who contributed funding or resources to the baseline inventory and community energy plan:

- Federation of Canadian Municipalities
- Festival Hydro
- Environment Canada
- Union Gas

APPENDIX A

CITY OF STRATFORD
REVIEW OF ENERGY EFFICIENCY OPPORTUNITIES
MODULE A – BUILDINGS

City of Stratford
Review of Energy Efficiency Opportunities

Module A
Buildings

Prepared for

City of Stratford

Prepared by

CH2MHILL

Contents

List of Tables

1. Review and Profile of Energy Consumption in Facilities

Background

This document is intended as a sub component to Stratford's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its commitment to the Federal Federation of Canadian Municipalities (FCM) Partners for Climate Protection Program (PCP program). The recommended Greenhouse Gas (GHG) reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 2003 energy use levels, by the year 2014.

The objective of this audit is to provide a high level review of various corporate buildings energy use and identify target areas where opportunities for improved energy use may exist. The facilities covered in this module include: City Hall Annex, Justice Building, City Hall, Administrative Buildings, Public Library, Public Housing, Anne Hathaway Day Care, Fire Station #1 and #2, Community Facilities, Municipal Airport, Public Works Garage, Traffic and Sewer Office Buildings.

Energy Use Trending and Benchmarking Performance

As a starting point for this module, it is useful to review historical energy use trends and benchmark the energy efficiency of each facility to its counterparts. Table 1.1 provides a facility and operational profile to demonstrate the size of the facilities and the different functions they perform. The facilities in this table were ones visited during by CH2M HILL personnel and not all city buildings are included in this profile. Table 1.2 is a more thorough list of City buildings.

TABLE 1.1
Facility Operational Profile

Facility	Area m^2	Date Built	Hours of Operation	Operational Profile
City Hall, Justice Building, and other Administration Buildings	Not Provided	Not Provided	5 days/week, 8am to 5pm Weekends: 7am to 4pm	Offices, Meeting Rooms, Council Chambers, Administrative functions
Public Library	2695	1903	6 days/week, 10am to 9pm Sunday: 12pm to 5pm	Offices, Public reading areas
Public Housing	Not Provided	Not Provided	7 days/week, 24 hours a day	Houses and Apartments

TABLE 1.1
Facility Operational Profile

Facility	Area m^2	Date Built	Hours of Operation	Operational Profile
Anne Hathaway Day Care Centre	495	1967	Monday to Saturday 6:30am to 5:30 pm	Childcare Facility
Fire Station #1	536	1968	7 days/week, 24 hours a day	Offices/Living Rooms, Apparatus
Fire Station #2	364	1979	7 days/week, 24 hours a day	Offices/Living Rooms, Apparatus
Community Facilities	Not Provided	Not Provided	Not Available	Not Available
Stratford Airport	Not Available	1991	Not Available	Not Available
Public Works Garage	948	1977	7 days/week, 24 hours a day	Garage, Stockroom, Offices
Traffic/sewer Building	438	1950	7 days/week, 24 hours a day	Garage, Stockroom, Offices

Table 1-2 provides a list of facilities arranged by North American Industry Classification (NAIC) code. The NAIC codes system is the method of the classification and billing of electricity used by Festival Hydro, Stratford's electricity provider. The facilities not included by an NAICS code are as follows: Public Housing and Municipal Airport. There was no electricity data provided for these two sites and they are excluded from GHG calculations.

TABLE 1.2
FACILITY NAIC CODE PROFILE

NAIC Code	NAIC Code Description	Facility
713990	Amusement & Recreation	Bowling Green
722210	Food Services	Food booth at Queens Park, Kiwanis
812220	Funeral Services	Cemetery and Mausoleum, Cemetery Chapel
913150	Municipal Regulatory Service	N/A
913140	Fire-fighting Services	Fire Hall 1 & 2
531120	Real Estate (Lessor Non-Residential)	Empty Building (Old Anna Banana Store)
532290	Rental (Other Consumer Goods)	N/A
711211	Teams & Clubs Services	National Stadium Ball Diamond
488990	Transportation & Transit	Romeo St. Railroad Underpass
485110	Transportation & Transit	Public Transportation Garage
562210	Waste Management	Landfill Site
913130	Police Services	Administration of Justice Building

TABLE 1.2
FACILITY NAIC CODE PROFILE

NAIC Code	NAIC Code Description	Facility
913910	Municipal Buildings, Parks and Miscellaneous	City Hall, Various Streetlights, Public Tennis Court, Baseball Diamond Complex, Millennium Park, Economics and Development Building, Metered Traffic Lights, SERC Sports Field, Ball Diamond Complex, Anne Hathaway Ball Diamond Complex, Anne Hathaway Park, Optimist Ball Park Diamond, Dufferin Ball Park Diamond, Albert Street Park, Public Works Garage, Traffic Department Garage, Shakespearean Gardens, Queens Park Pavilion and Washrooms, Parks Board Office Building, Centennial Park, City Hall Annex, Boat House
531111	Real Estate (Lessor Residential)	N/A
624110	Social Assistance	Youth Centre
624410	Social Assistance	Anne Hathaway Day Care
713940	Fitness & Recreation	Twin Ice Complex, Dufferin Arena, Allman Arena, Lions Club Swimming Pool
75500	N/A	N/A
63310	N/A	N/A
00000	N/A	N/A
99800	N/A	N/A

There is some overlapping of facilities between Table 1-1 and 1-2. As Table 1-1 indicates, the range of facilities reviewed in this module varies greatly in terms of size, operational hours and function. The Fire Stations and Public Housing, as well as the Public Works Garage, operate constantly on a daily basis while City Hall and other administration buildings follow a routine business schedule. There is no information for the operation of the community centres as they vary from routine hours to more sporadic hours depending on season and centre. As can been seen with Table 1-2, each NAIC code corresponds with multiple facilities; subsequently, there is no disaggregation of Festival Hydro electricity information and data for individual facilities. There is also no facility information provided for NAIC code 913150, 532290, 531111, 75500, 63310, 00000, and 99800.

Based on these different operational profiles and the lack of specific data, the ability to compare facilities to each other is limited. Consumption profiles will be directly related to the NAIC code and not individual buildings.

Overall Energy Consumption

Figure 1-1 provides an historical trend of overall electricity use in the City of Stratford's corporate buildings from 2001 to 2005. The trend line indicates the corresponding GHG emissions from electricity use. The total overall electricity use for the city increased by 14.1 percent from 2001 to 2005, while the amount of CO2e emissions decreased by 6.2 percent. The decrease in emissions can be explained by the decrease in electricity emission coefficients. The electricity emission coefficient represents the amount of emissions resulting from the generation of a given quantity of electricity. The coefficients are calculated annually by Environment Canada based on an average provincial electricity generation mix (the fuel sources used to generate electricity such as coal, natural gas, oil, nuclear, hydro, and renewable) and may change annually due to a number of factors such as fuel types, intra-provincial generation, inter-provincial inflows and imports from the United States. As a result, there is a decrease in emissions despite an increase of electricity use in 2005 from values from years prior to 2004.

FIGURE 1-1

Overall Co_2 Emissions (Tons) Derived From Electricity Use

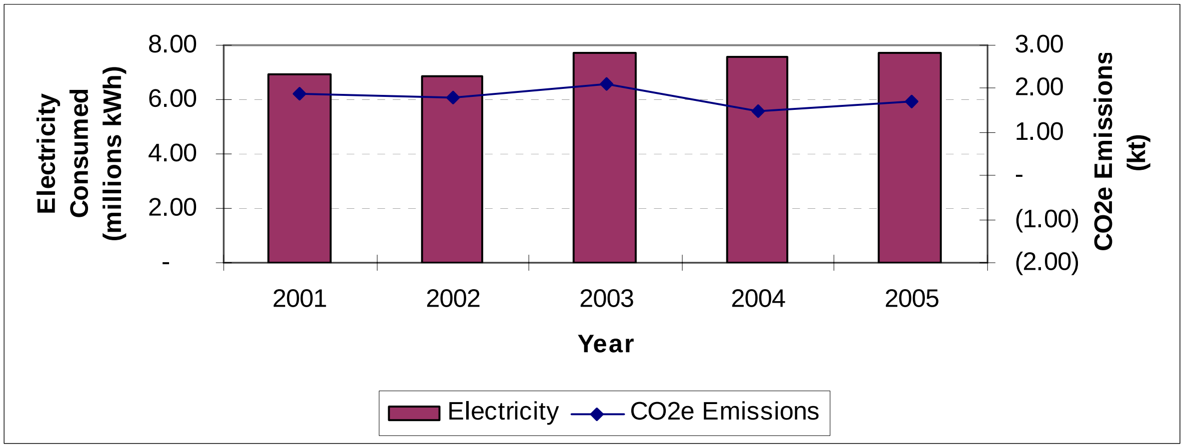


Table 1.3 presents the CO_2e emission differences between 2003 and 2005 for Stratford's facilities on a NAIC code basis.

TABLE 1.3

Co_2e Reduction Targets (Derived From Electricity Use)

NAIC	NAIC Code Description	2003 CO2e (tonnes)	2005 CO2e (tonnes)	20% Reduction from 2003	Reduction from 2003 to meet 20% target
713990	Amusement & Recreation	32	28	25	2
722210	Food Services	11	6	8	(2)
812220	Funeral Services	6	4	5	(0)
913140	Fire-fighting Services	25	20	20	(0)
913150	Municipal Regulatory Service	0	5	0	5
531120	Real Estate (Lessor Non-Residential)	0	2	0	2
532290	Rental (Other Consumer Goods)	12	9	10	(1)
711211	Teams & Clubs Services	3	3	3	(0)
488990, 485110	Transportation & Transit	17	42	14	28
562210	Waste Management	50	37	40	(3)
519121	Information Service	60	46	48	(2)
913130	Police Services	133	98	106	(9)
913910	Municipal Buildings, Parks and Miscellaneous	480	388	384	4
531111	Real Estate (Lessor Residential)	236	193	189	4

TABLE 1.3
CO_2e Reduction Targets (Derived From Electricity Use)

NAIC	NAIC Code Description	2003 CO2e (tonnes)	2005 CO2e (tonnes)	20% Reduction from 2003	Reduction from 2003 to meet 20% target
624110, 624410	Social Assistance	62	42	50	(8)
713940	Fitness & Recreation	179	144	143	1
75500, 63310, 00000, 99800	N/A (No NAIC description found)	793	633	635	(1)
Totals		2,100	1,700	1680	20

As indicated in Table 1-3, there has been a decrease of approximately 400 tonnes of CO_2e from 2003 to 2005. Note, electricity consumption by Stratford in 2005, however, had increased from 2001 consumption; the decrease in CO_2e emissions is due to the lower electricity grid emission intensity coefficient in 2005 than in 2003. The electricity grid emission intensity coefficient varies annually and though the coefficient may be lower in 2005 than 2003, it may not be the case in the following years. A 20% reduction from 2003 emission values is 1680 CO_2e tons, which means a reduction of 20 CO_2e tons from 2005 is needed to meet the target.

With the given electricity data, it is difficult to compare the total electricity usage by NAIC codes. To provide a basis of comparison, total electricity usage by NAIC code has been divided by the number of facilities which corresponds with a given NAIC code for each NAIC code to provide an energy intensity factor. NAIC code 913910 (Municipal buildings, parks and miscellaneous) represents the greatest number of facilities, as shown in Table 1.4.

TABLE 1.4
Summary of Total Electricity Usage and Intensity for NAICS Code

NAICS Code	NAICS Description	Number of Facilities	Combined Area	2003 Electricity Use (MWh)	2003 Intensity MWh / m^2	2005 Electricity Use (MWh)	2005 Intensity MWh / m^2
713990	Amusement & Recreation	2	N/A	116,458	58,229	126,483	63,241
722210	Food Services	2	N/A	38,485	19,243	29,148	14,574
812220	Funeral Services	3	N/A	21,971	7,324	19,795	6,598
913140	Fire-fighting Services	2	900	92,187	46,093	90,301	45,150
913150	Municipal Regulatory Service	N/A	N/A	-	-	20,549	20,549
531120	Real Estate (Lessor Non-Residential)	1	N/A	1,821	1,821	11,024	11,024
532290	Rental (Other Consumer Goods)	N/A	N/A	44,421	44,421	40,900	40,900
711211	Teams & Clubs Services	1	N/A	12,288	12,288	11,978	11,978
488990, 485110	Transportation & Transit	2	N/A	63,030	31,515	192,024	96,012
562210	Waste Management	1	N/A	183,338	183,338	166,259	166,259
519121	Information Service	1	2695	220,162	220,162	207,539	207,539

TABLE 1.4
Summary of Total Electricity Usage and Intensity for NAICS Code

NAICS Code	NAICS Description	Number of Facilities	Combined Area	2003 Electricity Use (MWh)	2003 Intensity MWh / m^2	2005 Electricity Use (MWh)	2005 Intensity MWh / m^2
913130	Police Services	1	N/A	486,748	486,748	444,451	444,451
913910	Municipal Buildings, Parks and Miscellaneous	22	N/A	1,756,731	79,851	1,764,114	80,187
531111	Real Estate (Lessor Residential)	N/A	N/A	865,554	865,554	876,184	876,184
624110, 624410	Social Assistance	2	N/A	228,835	114,418	192,311	96,156
713940	Fitness & Recreation	4	N/A	655,345	163,836	654,090	163,523
75500, 63310, 00000, 99800	N/A (No NAIC description found)	N/A	N/A	2,905,453	2,905,453	2,878,687	2,878,687

If the number of facilities is unknown for a particular NAIC code, assume there is one facility for that NAIC code for electricity intensity calculating purposes

Historical Energy Use Patterns

A review of available historical energy use patterns can provide insight into changing operational patterns or significant load additions at each facility. Figures 1-2, 1-3 and 1-4 provide historical perspectives of electricity usage at each NAICS code from January 2001 to December 2005. The major electricity users (average monthly electricity use of 11,000 kWh or more) can be found on within Figure 1-2, medium electricity users (average monthly electricity use of 3,500 to 10,999 kWh) on Figure 1.3 and minor electricity users (average monthly electricity use of 3,499 KWh or less) on Figure 1-4.

Upon review of the major electricity users shown in Figure 1-2, it is apparent that the NAICS codes without a description provided consumes the most electricity and by a significant amount. After 2002, the facilities with these NAICS codes experienced significant peaks in electricity use in the past, typically in the winter months. These peaks can potentially be due to weather extremes creating more demand upon heating and cooling systems; such as, the blowers, pumps, air handling units and other equipment, which distribute the warm/cold air and hot water throughout the building.

FIGURE 1-2
Historical Electricity Use (Major Users) By NAICS Code (January 2001 – December 2005)

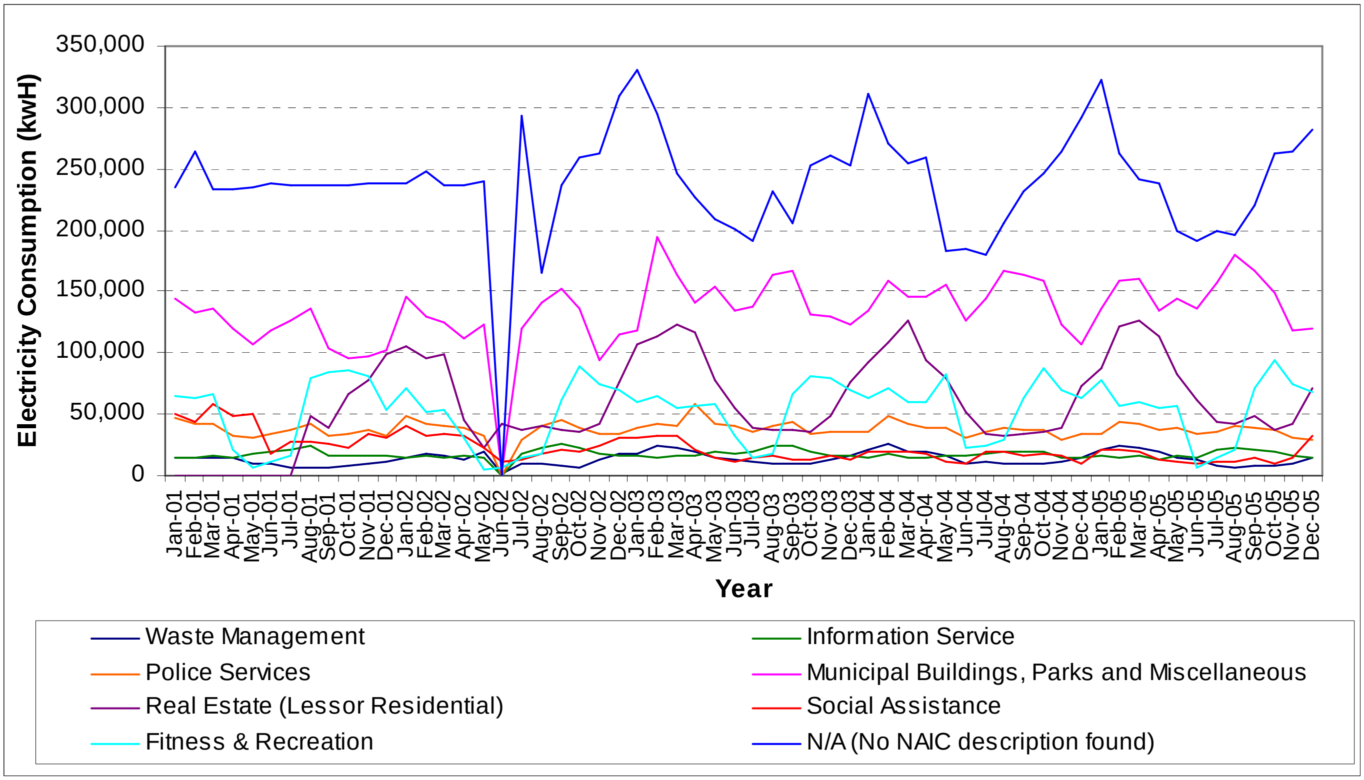
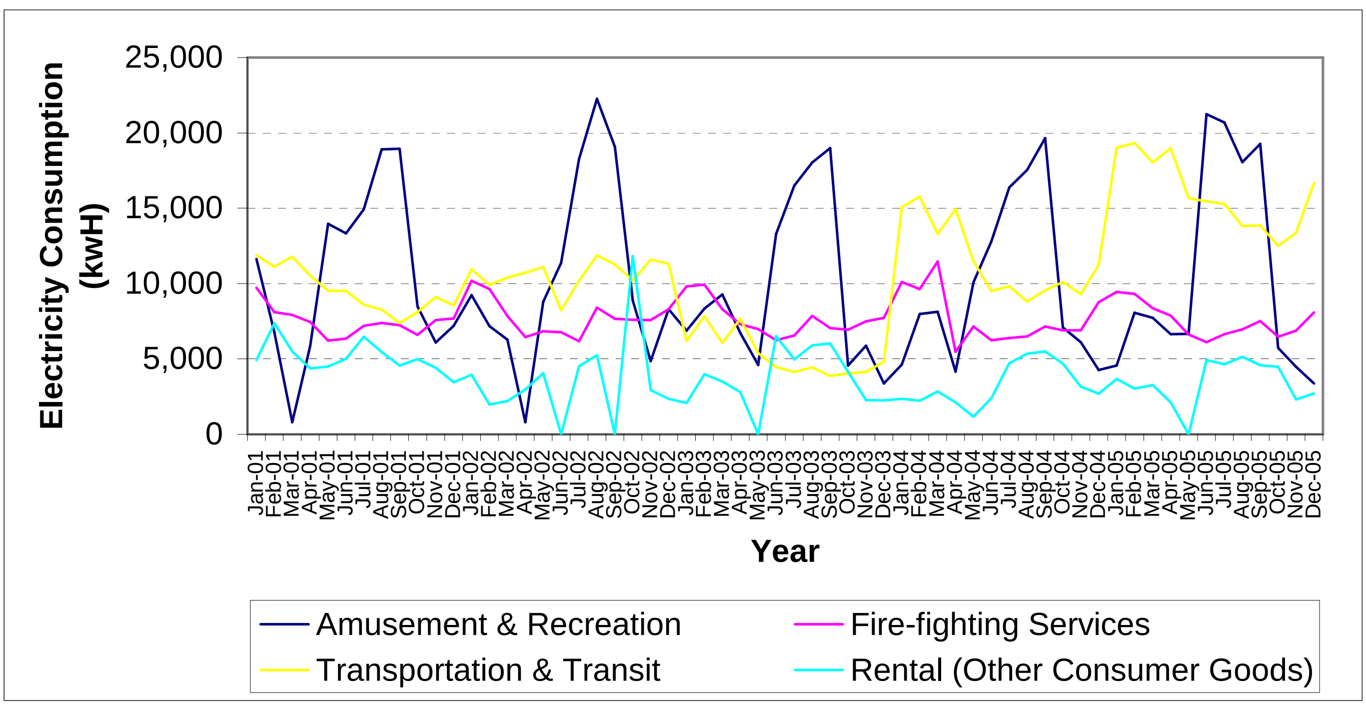


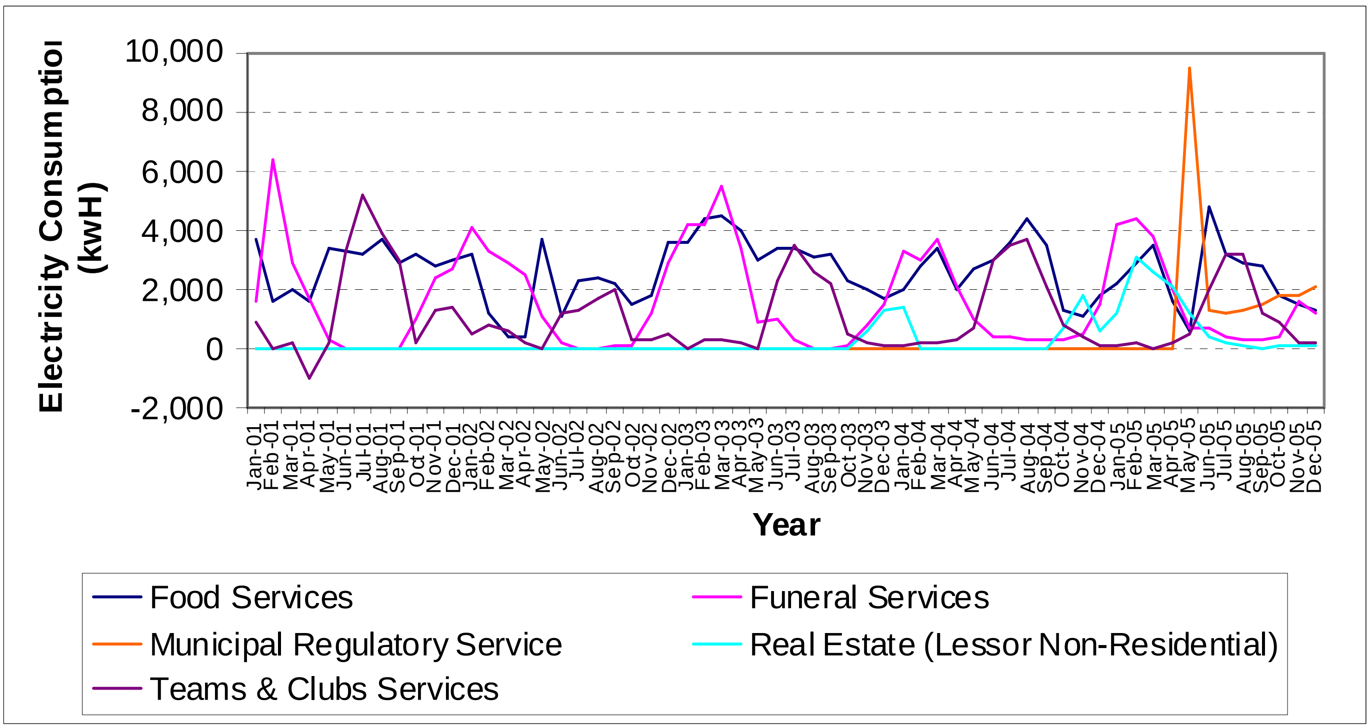
FIGURE 1-3
Historical Electricity Use (Medium Users) By NAICS Code (January 2001 – December 2005)



As seen in Figure 1-3, facilities which fall under the Amusement and Recreation and Rental (Other Consumers Goods) NAICS code exhibit a pattern where the highest use is in the summer months. All the other NAICS code categories' patterns are inversed with peaks The Transit Terminal has experienced a regular electricity use pattern use from 1994 to 2000 with peak demands typically falling in the winter months. Support equipment associated with the natural gas heating system is likely resulting in the increased demand occurring in the winter months.

The electricity usage for Transportation and Transit facilities have increased throughout the years whereas all the facilities with other NAICS codes experience no significant increase or decrease in usage on a annual basis.

FIGURE 1-4
Historical Electricity Use (Minor Users) By NAICS Code (January 2001 – December 2005)



Similarly, upon review of Figure 1.4, it can be seen that facilities with the NAICS code for Funeral Services consume the greatest amounts of electricity in the winter months whereas facilities with the NAICS codes for Teams and Clubs services display the opposite trend where air conditioning demand is higher for active sports. The facilities that fall under the NAICS code for Food Services do not appear to display any regular trend. Only in the more recent years has there been data for facilities for NAICS codes Real Estate (Lessor Non-Residential) and Municipal Regulatory Service been included. This may be because these facilities are fairly new, and therefore not enough information to conclude trends for these facilities.

2. Potential Opportunities for Improved System Energy Efficiency

The opportunities presented in this section are initial recommendations for energy efficiency improvement. Further detailed evaluation is required for each measure.

General Knowledge/Awareness of Energy Consumption

All Facility Personnel interviewed during the process were very conscience of energy efficiency and demonstrated a keen interest in the operation of their respective buildings. Each operator had general knowledge of the facilities they managed; however, the particular operating details of the HVAC and hot water heating among other electrical loads were not readily available during the interview due to the complexity of some systems and the level of responsibility of the operator who are required to look after several buildings.

Equipment Inventory and Operational Profile Manual

It is recommended that the equipment inventory and operational design parameters are established in a manual for each facility along with roles and responsibilities for maintaining operations within defined parameters. This would facilitate better operation and knowledge of equipment efficiency.

Energy Use and Operational Profile Logging

While all Facility Operations personnel interviewed were conscience of energy usage, they were not aware of actual consumption levels. In this context, Operators do not directly see the impact of their efforts and tend to focus more on protocol than results.

By adding daily meter readings to the current operating regimen, staff will be able to see how the facility is operating on a daily basis. It has been demonstrated that daily meter readings will encourage even tighter energy use control and identify any trends of mal-operating equipment. In addition, staff will often find their own new and innovative ways to reduce energy usage when its profile and importance is raised.

Sub-Metering

For the most part, all facilities in this module have one main gas meter (if present) and one main electrical meter with no sub-metering. The addition of sub-metering would allow for the identification of energy cost centres and prioritize areas of each facility that need to be addressed.

Sub-meters will help identify ways to reduce energy spikes, reduce utility demand charges and prioritize efforts for energy conservation.

Electricity sub-metering can be done with either a dedicated meter or a portable clamp-on amp meter/data logger that can be used throughout each facility.

Metering will have to be analyzed for cost effectiveness. Manual data logging may indirectly increase costs through data management compared to the potential energy savings. Automated systems may have more initial capital costs.

Network of Energy Management Systems

It is recommended that the City install a network of energy management systems. This would involve the installation of the Energy Management Control Systems (EMCS) utilizing stand alone Direct Digital Control (DDC) for all energy using equipment in order to maximize energy saving and effectiveness. The EMCS of major City facilities could then be connected to the Network (Intranet) in order to achieve improved control and savings. This system will allow for both local and remote access over a secure Intranet/Internet.

Energy Policies

The City should consider establishing policies related to indoor temperature set points for both heating and cooling when the buildings are occupied and generally unoccupied. In addition, establishing a “light out” policy whereby lights are turned off in the city buildings after business hours is also an energy efficiency initiative that should be considered by the City.

Training

Significant energy savings can be accomplished by special training to the staff operating the building and facility managers with regards to the latest energy saving technologies, along with the proper installation and maintenance of the complex building mechanical equipment.

Communications

Another simple communications initiative is to bring energy conservation at work to the attention of City staff by broadcasting energy reduction messages across the corporation, and developing an employee suggestion program for workplace energy efficiency ideas.

New Technologies for Future Projects

The City should also consider the following new technologies for future projects:

- Use of heat recovery systems such as plate heat exchanger, heat pipe, or run around loop for the air handling system that provides a high outside ventilation rate. use of new or renewable technology initiatives for future projects where feasible, including photovoltaic systems, solar energy wall, green roof, ground source heat pump.

Work to achieve green building standard LEED (Leadership in Energy and Environmental Design) for future projects where feasible.

Facility Specific Opportunities

The following section provide descriptions of existing building mechanical systems and also outline specific and general energy efficiency recommendations for specific buildings within the City of Stratford.

City Hall Annex

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating and VVT control system. These systems were upgraded in 2002. The supplement heating is provided by electric baseboard heaters.
- The lighting systems were upgraded with high efficiency lights and manual on/off.
- Plumbing fixtures were provided with low flow water features.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each floor.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Provide adequate local control.
- Expand operating manuals to include information about each piece of equipment, such as its efficiency as well as it's electrical/gas demand and the area it services.

Other Recommendations

- Insulate hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.

- When the existing large motors (greater than 1 HP) are needed to replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Justice Building

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating and VVT control system. The air conditioning systems were upgraded in 2006.
- The lighting systems were upgraded with high efficiency lights and manual on/off.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each floor.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off in certain locations or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas use in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Provide adequate local control.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Provide a separate air conditioning unit for cooling of the Court room since the cooling load from the Court room must be specially designed for the number of people over a period of time each day. This system will meet the cooling requirements when this room is in use with a large number of people. It would be off when there is non one in the Court room. The central air conditioning would be utilized to provide cooling for the rest of the building only.
- Insulate hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.

- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

City Hall

Existing Building Mechanical Systems

- The HVAC systems include the air handling units, fan coil units, three air cooled chillers for cooling and gas fired boiler systems for heating.
- The lighting systems were upgraded with high efficiency lights and manual on/off.
- The mechanical systems were upgraded with time clock and controllers.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each floor.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increase during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Provide adequate local control.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as it's electrical/gas demand and the area it services.

Other Recommendations

- There are significant amounts of heat loss in the ceiling through the attic. A report from the city noted that attic temperatures are kept above 4° C to keep snow and ice from forming on the slope roof. It is expensive to heat the entire attic because there is heat loss in winter as well as cooling loss in the summer. A cost effective solution would be for the City to insulate the attic and ductwork to prevent heat and cooling loss, then install snow melting cable on the roof to prevent ice from being formed.
- Insulate hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.

- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

47 Downie Street

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating. The existing HVAC systems were upgraded in 2003.
- The lighting systems were upgraded with high efficiency lights and manual on/off.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each floor and the new addition.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Provide adequate local control.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as it's electrical/gas demand and the area it services.

Other Recommendations

- Insulate hot water tanks and associated piping.
- Use tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Install ceiling fans in the lobby to push the hot air down in winter and pull hot air up to exhaust to outside in summer.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Public Library

Existing Building Mechanical Systems

- The library is an old building that was built in 1903 with 1925 and 1975 additions. The central heating/cooling systems include four old rooftop gas fired/refrigerant cooling units.
- The lighting systems were upgraded with high efficiency lights and manual on/off.
- The old windows were replaced with new thermal windows in 2001.
- The old boiler was replaced with new high efficiency boiler in 2004 to provide supplemental baseboard heating along the windows.
- Cooling for server room was provided by new air conditioning unit.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each floor and the new addition.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Provide adequate local control.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Insulate the attic to prevent heating and cooling loss.
- Insulate hot water tanks and associated piping.
- Use tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Public Housing

Existing Building Mechanical Systems

- All the apartment buildings are provided with electric baseboards for heating.
- A few of the existing apartments are provided with natural gas fired make up air units (45 Buckingham Dr.) or with electric make up air units (62 Cawston St.) to provide outside make up air.
- All the public houses are provided with gas fired furnaces (less than 10 years old) for heating and new window air conditioners. Tenants pay for the window air conditioning units by themselves.

General Recommendations

- Assess the distribution of load throughout the facilities; electrical sub-meters could be installed for each apartment.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Replace the existing make up air units with heat recovery system and gas fired heating units.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Due to the number of different tenants, individual electricity demands should be tracked separately in addition to the overall facility. Implementing sub-meters to assess usage by different tenants would be valuable in identifying and tracking peak load demands.
- Renters should be advised of the proper use of the facility heating/cooling system and given operating instructions to follow while the facility is in use as well as a check list of items to address when they leave. For example, thermostats settings should be specified.
- Provide adequate local control.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Replace the existing make up air units with gas fired heat recovery units to recover the heat from exhaust air and transfer that heat to preheat the outside supply air.
- Upgrade the lighting systems with high efficiency lights.
- Insulate hot water tanks and associated piping.
- Use tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.

- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Anne Hathaway Day Care Centre

Existing Building Mechanical Systems

- The cooling systems are provided by four refrigerant cooling coils with outdoor condensing units.
- The heating systems are provided by three old forced flow gas fired furnaces.

Facility Recommendations

- Implementing gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.

Other Recommendations

- The existing furnaces are old. Replace them with new high efficiency gas fired furnaces.
- Replace the old windows with new thermal windows.
- Insulate ductwork, hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Upgrade the lighting systems with high efficiency lights.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Fire Station No. 1

Existing Building Mechanical Systems

- The cooling systems are provided by four window units. New split air conditioning unit with outdoor condensing unit was installed in dispatch.
- The heating system for the south section (office and living areas) is provided by a 17 year old gas fired boiler.
- The heating systems for the north section (Apparatus floor) is provided by four gas fired unit heaters.

Facility Recommendations

- Implementing gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.

Other Recommendations

- The existing boiler is old. Replace it with a new high efficiency gas fired boiler.
- When the window air conditioning units need to be replaced in the future, consider replacing them with indoor Mitsubishi air conditioning units and one variable refrigerant outdoor condensing unit to save energy.
- Replace the old windows with new thermal windows.
- Insulate hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Upgrade the lighting systems with high efficiency lights.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.
- Gas fired unit heaters normally operate to heat the air of the whole room at a high energy cost. When unit heaters in the garage have reached their life expectancy, replace

them with a radiant heater. Radiant heaters are recommended over unit heaters since they have higher efficiency, they are excellent for dry and wet surfaces, and they permit the space to be maintained at lower temperatures while still achieving good occupant comfort levels.

Fire Station No. 2

Existing Building Mechanical Systems

- The cooling systems are provided by three window units.
- The heating systems for the east section (office and living areas) are provided by a 28 year old gas fired boiler.
- The heating systems for the west section (Apparatus floor) are provided by two gas fired unit heaters.

Facility Recommendations

- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.

Other Recommendations

- The existing boiler is old. Replace with a new high efficiency gas fired boiler.
- When the window air conditioning units need to be replaced in the future, consider replacing them with indoor Mitsubishi air conditioning units and one variable refrigerant outdoor condensing unit to save energy.
- Replace the old windows with new thermal windows.
- Insulate hot water tanks and associated piping.
- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Upgrade the lighting systems with high efficiency lights.

- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.
- Gas fired unit heaters normally operate to heat the air of the whole room at a high energy cost. When unit heaters in the garage have reached their life expectancy, replace them with a radiant heater. Radiant heaters are recommended over unit heaters since they have higher efficiency, they are excellent for dry and wet surfaces, and they permit the space to be maintained at lower temperatures while still achieving good occupant comfort levels.

Community Facilities

Existing Building Mechanical Systems

Through interviews with the Community Facilities Manager, it was determined that all community facilities are operated similarly and had the following equipment/operation upgrades to each facility:

- The exhaust fans of kitchens and washrooms were interlocked with timer or lighting switch to operate only when required.
- The lighting systems were upgraded with high efficiency lights with manual on/off or local occupancy sensor.
- The domestic hot water recirculation pumps and water heaters were de-energized during unoccupied periods.
- All electric baseboard heaters were de-energized during unoccupied periods.
- Building temperatures were set back during unoccupied periods.
- Some of the electric boilers and water heaters were replaced with gas fired units.
- Some of the large existing motors were replaced with new high efficiency models.

General Recommendations

- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.

Other Recommendations

- When the existing boilers need to be replaced in the future, replace them with new high efficiency gas fired boilers.

- When the existing electric water heaters need to be replaced in the future, replace them with new high efficiency gas fired tank-less water heaters. Set hot potable water temperature no higher than 50 degrees C.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.
- When the window air conditioning units need to be replaced in the future, consider replacing them with indoor Mitsubishi air conditioning units and one variable refrigerant outdoor condensing unit to save energy.
- Replace the old windows with new thermal windows.
- Insulate hot water tanks and associated piping.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.

Municipal Airport

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating and VVT control system.
- Part of the lighting systems was upgraded with high efficiency lights and manual on/off.

General Recommendations

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Use tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.

- Provide insulation for air conditioning ductwork to prevent cooling and heating loss.
- Upgrade the lighting systems with high efficiency lights.
- When the existing large motors (greater than 1 HP) need to be replaced in the future, replace them with new premium efficiency motors. Use variable speed drive on large motors (greater than 5 HP) where feasible.

Public Works Garage, Stockroom, and Office Building

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating.
- The garage and workshop are heated with gas fired unit heaters.

General Recommendations

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Install tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Upgrade the lighting systems with high efficiency lights.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Provide insulation for air conditioning ductwork to prevent cooling and heating loss.
- Installing a programmable thermostat in the garage to control gas unit heaters. This will also help moderate temperatures.
- Isolate the workshop area and provide radiant gas tube heaters with programmable thermostat. Gas fired unit heaters normally operate to heat the air of the whole room at a high energy cost. When unit heaters in the garage have reached their life expectancy, replace them with a radiant heater. Radiant heaters are recommended over unit heaters

since they have higher efficiency, they are excellent for dry and wet surfaces, and they permit the space to be maintained at lower temperatures while still achieving good occupant comfort levels.

- Provide new insulated overhead doors for the garage to save energy.
- Insulate hot water tanks and associated piping.

Traffic and Sewer Office Building

Existing Building Mechanical Systems

- The HVAC systems include air handling units with refrigerant cooling and gas fired heating.
- The Equipment Storage room is heated with gas fired radiant heaters.

General Recommendations

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day. Implement more task lighting at work stations and evaluate lighting requirements on an office by office basis.
- Implement gas sub-meters to assess usage by HVAC and water heaters.
- Re-evaluate electricity and gas usage in conjunction with the buildings programmable settings to ensure optimal settings are being used.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.
- Expand the manual to include information about each piece of equipment, such as its efficiency as well as its electrical/gas demand and the area it services.

Other Recommendations

- Use tank-less water heaters when the existing water heaters must be replaced. Set hot potable water temperature no higher than 50 degrees C.
- Upgrade the lighting systems with high efficiency lights.
- Replace existing plumbing fixtures with low flow water plumbing fixtures.
- Provide insulation for air conditioning ductwork to prevent cooling and heating loss.
- Installing a programmable thermostat in the Equipment garage to control gas radiant heaters. This will also help moderate temperatures.
- Provide new insulated overhead doors for the garage to save energy.
- Insulate hot water tanks and associated piping.

APPENDIX B

CITY OF STRATFORD CORPORATE ENERGY PLAN
REVIEW OF ENERGY EFFICIENCY OPPORTUNITIES
MODULE B – FLEET OPERATIONS

City of Stratford Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module B:
Fleet Operations

Prepared for

City of Stratford

Prepared by

CH2MHILL

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1. Review and Profile of Fleet Energy Consumption

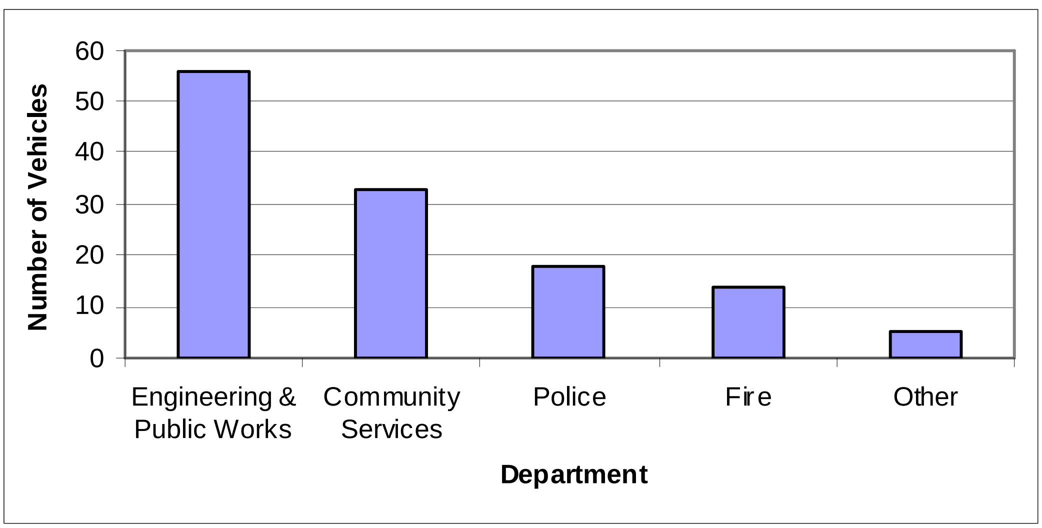
Background

This document is intended as a sub component to Stratford's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its commitment to the Federation of Canadian Municipalities (FCM) Partners for Climate Protection (PCP) Program. The recommended greenhouse gas (GHG) reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 2003 energy use levels, by the year 2014. However, due to a lack of available Fleet Fuel Consumption data, for this module the year in which future emissions will be measured against is 2005, the year with the most available data.

Fleet Operations

Departments within the City of Stratford operate and maintain their own fleet of vehicles. Each department has inventory and fuel records of their fleet; such data was provided to the Consultant for the purpose of this Module. The department fleets range in vehicles types according to the department operations. The number of vehicles per department is identified in Figure 1-1.

FIGURE 1-1
Number of Vehicles by Department



Most of the departments run independently from one another. There is no standardized City wide system of operating the City's vehicles. Fuel is usually managed directly by the individual departments.

Department Fleet Vehicle Description

Engineering and Public Works

The Engineering and Public Works department provides routine maintenance and supervises the construction of the City's roads, the wastewater collection system, solid waste management, and landfill operations, and is responsible for the production, treatment, and distribution of potable water for the City. The department consists of 44 vehicles, which typically include passenger vehicles and pick-up trucks. The department also operates 1-ton and 5-ton trucks as well as pumper trucks and street sweepers. Engineering and Public Works vehicles are fueled at the fuelling station located at 303 King Street.

Community Services

The Community Services Department runs a fleet of 26 vehicles for the purpose of operating and maintaining the cemetery, parks and recreation facilities, and operating water distribution services. The Community Services fleet consists mainly of passenger vehicles, 1-ton trucks and heavy diesel equipment and small gasoline engines. Some mechanical work for the cemetery, parks and recreation, and water division vehicles are conducted in the Transit Department garage. Most Community Services' vehicles are fueled at the fuelling station located at 27 Morenz Drive. Vehicles associated with maintaining the cemetery are fuelled at 4 Avondale Avenue.

Transit

The Transit Department is a subdivision of Community Services but operates as its own department. The Transit department owns a total of 20 vehicles. There is a fleet of 17 buses, 14 of which are standard buses and the remaining are low floor buses. The remaining 3 vehicles of the fleet are for miscellaneous purposes, such as emergency replacement vehicle.

There are six bus routes in the City, each averaging a distance of 9 kilometers. The buses service an area of 18.90 square kilometers and a ridership of approximately 582,807 passengers per year. The transit station consists of a wash and fuel bay, two repair bays and parking for 16 buses. The fuel bay does not fuel any vehicles other than the department buses. The department collaborates with Community Services to conduct the mechanical and maintenance work for buses and the rest of the Community Service fleet. Buses are fuelled at 60 Corcoran Street.

Police Department

The Police Department is represented by 18 vehicles, consisting mainly of passenger vehicles.

Fire Department

The Fire Department is represented by 14 vehicles, including passenger vehicles, pumpers and cranes. The Fire Department vehicles are fueled at the fuelling station located at 388 Erie Street.

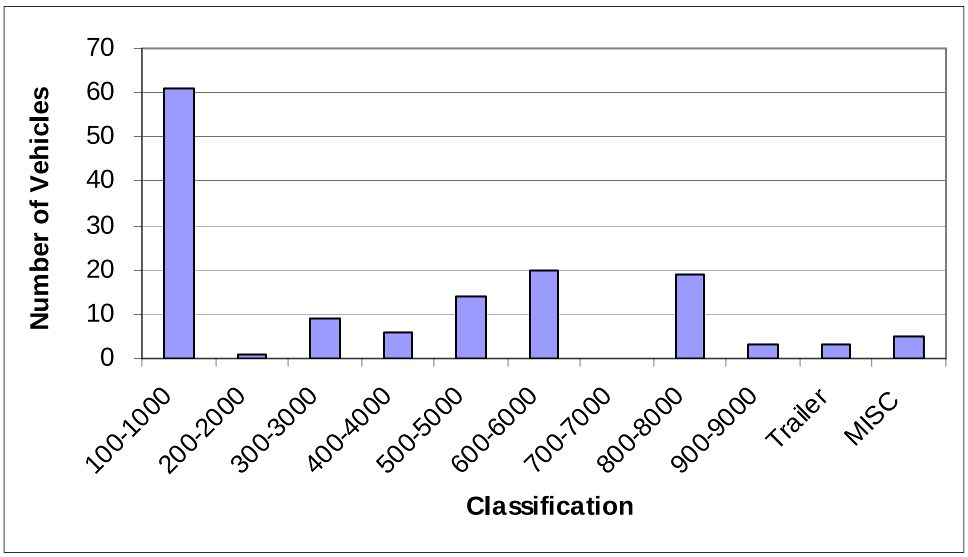
Other

This category represents vehicles in the following departments: Meter, Building and Planning, and Economic. There are a total of 5 cars in this category.

Classification Description

There is no fuel consumption, type or mileage data for the different types of classification. Stratford was not able to provide a thorough list of vehicles and corresponding Classification Description; where information was not provided, the Consultant placed vehicle in Series based on type of car and Classification Description. The numbers of vehicles per various types of vehicles are identified in Figure 1-2.

FIGURE 1-2
NUMBER OF VEHICLES BY CLASSIFICATION



100 – 1000 Series

The 100 Series includes all passenger vehicles and pick-up trucks. Approximately 50 percent of the stock in this class is pick-up trucks and small vans (e.g., Ford F-150, Dodge 1500). Vehicles in this class are used for a wide range of utility purposes for the works crews throughout the City.

200 – 2000 Series

The 200 series primarily represents various off-road tractors used by the City. There are no such vehicles on the City's inventory list.

300 – 3000 Series

1 Ton Trucks are classed in the 300 Series (e.g., Ford F-350, GMC 3500). 1 Tons are generally purchased for specific applications such as: traffic bucket for street light change-out, garbage compactor and sewer inspection/maintenance.

400 – 4000 Series

The 400 Series includes the pumper and crane trucks used by the Fire Department.

500 – 5000 Series

5 Ton Diesel Trucks are classed in the 500 Series. Truck in this category include: fire trucks, snow plows and blowers, sanders, snow melter and sewer vactor trucks.

600 – 6000 Series

The 600 Series represents the city transit buses.

700 – 7000 Series

The 700 Series includes street sweepers and other antique vehicles.

800 – 8000 Series

All heavy diesel equipment is classed in the 800 Series. This would include road graders, back hoes, bulldozers and compactors.

900 – 9000 Series

The 900 Series is reserved for all small gasoline engines. This would include push mowers, weed wackers, small pumps etc.

Trailers Series

The Trailers Series represents trailers that a department may own. Trailers do not have engines and are dependent on other vehicles to move.

MISC Series

The MISC Series represents vehicles that did not fall under any of the above series or sufficient information was not provided for classification purposes.

Fuel Type and Consumption by Department

The primary decision factors for selecting engine type is cost, engine availability and durability under expected operating conditions; environmental reasons is not a factor and there is neither department nor City-wide policy in purchasing vehicles with consideration for environmental impacts. For smaller lighter vehicles and equipment (equal to or less than 2 ton) the City predominantly selects unleaded gasoline engines. For heavy equipment and vehicles (more than 2 ton), diesel is selected for durability and reduced maintenance cost.

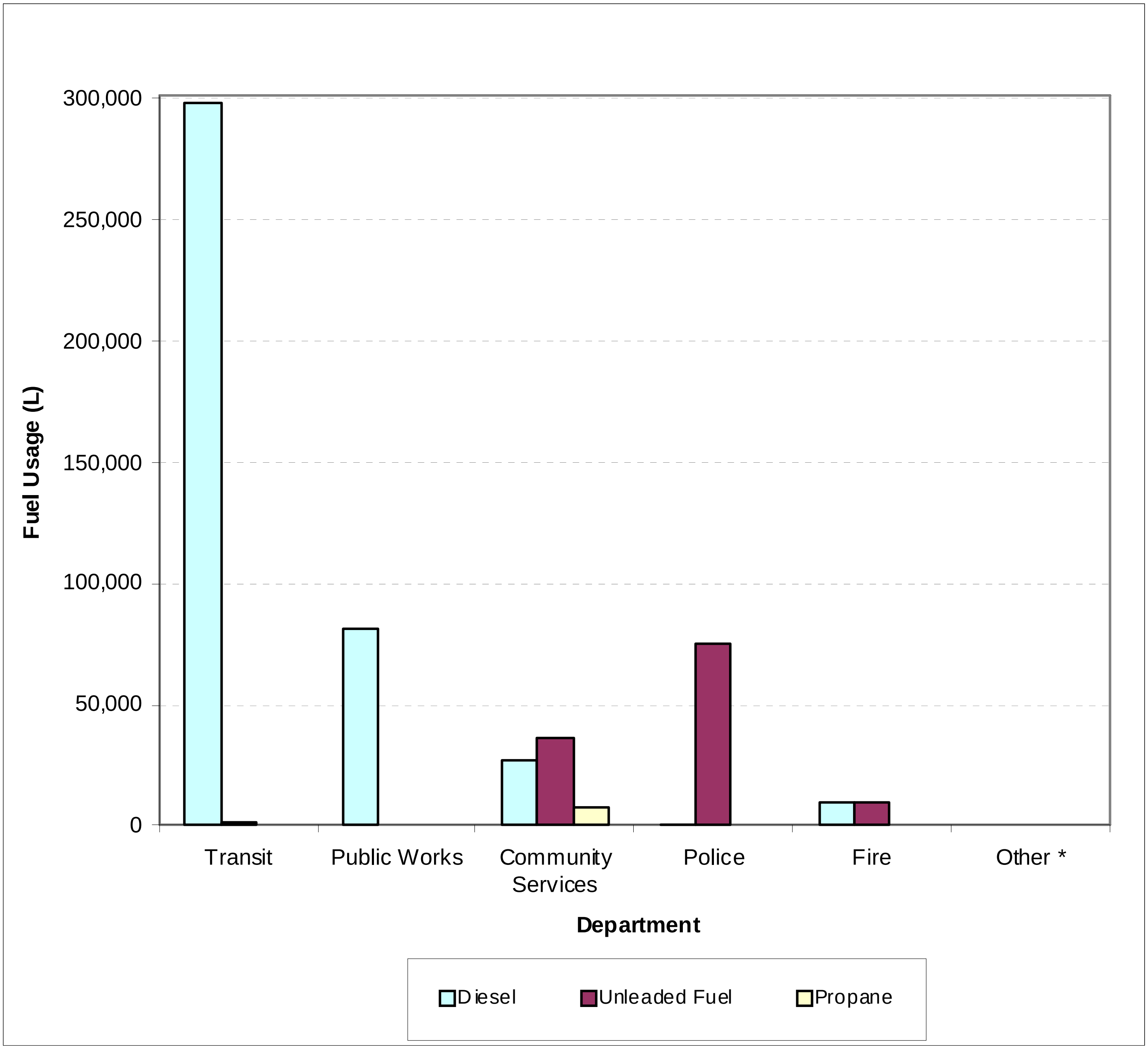
The Public Works and Community Services departments experimented with using propane as an alternate fuel in their vehicles through the late 1990's and ending in 2000 due to conversion costs and fuel availability. There has also been experimentation with using biodiesel as fuel in transit buses. This program has not expanded due to fuel cost and refueling capabilities.

Figures 1-3 and 1-4 illustrate the annual fuel use by department and vehicle class, respectively. Figures 1-5 and 1-6 on CO_2e emissions exhibit the amount of CO_2e generated by fuel consumption. These figures are based on the assumptions the administration system for tracking fuel usage is correct and complete. In actuality, this information is not complete due to the following:

- Incomplete Community Services data; there is no data for the Cemetery division prior to 2005 and there is no data for the year 2003.
- Incomplete data for the Police departments; there is no data of fuel consumption prior to year 2005.
- Unavailable data for the departments that fall under the Other category.

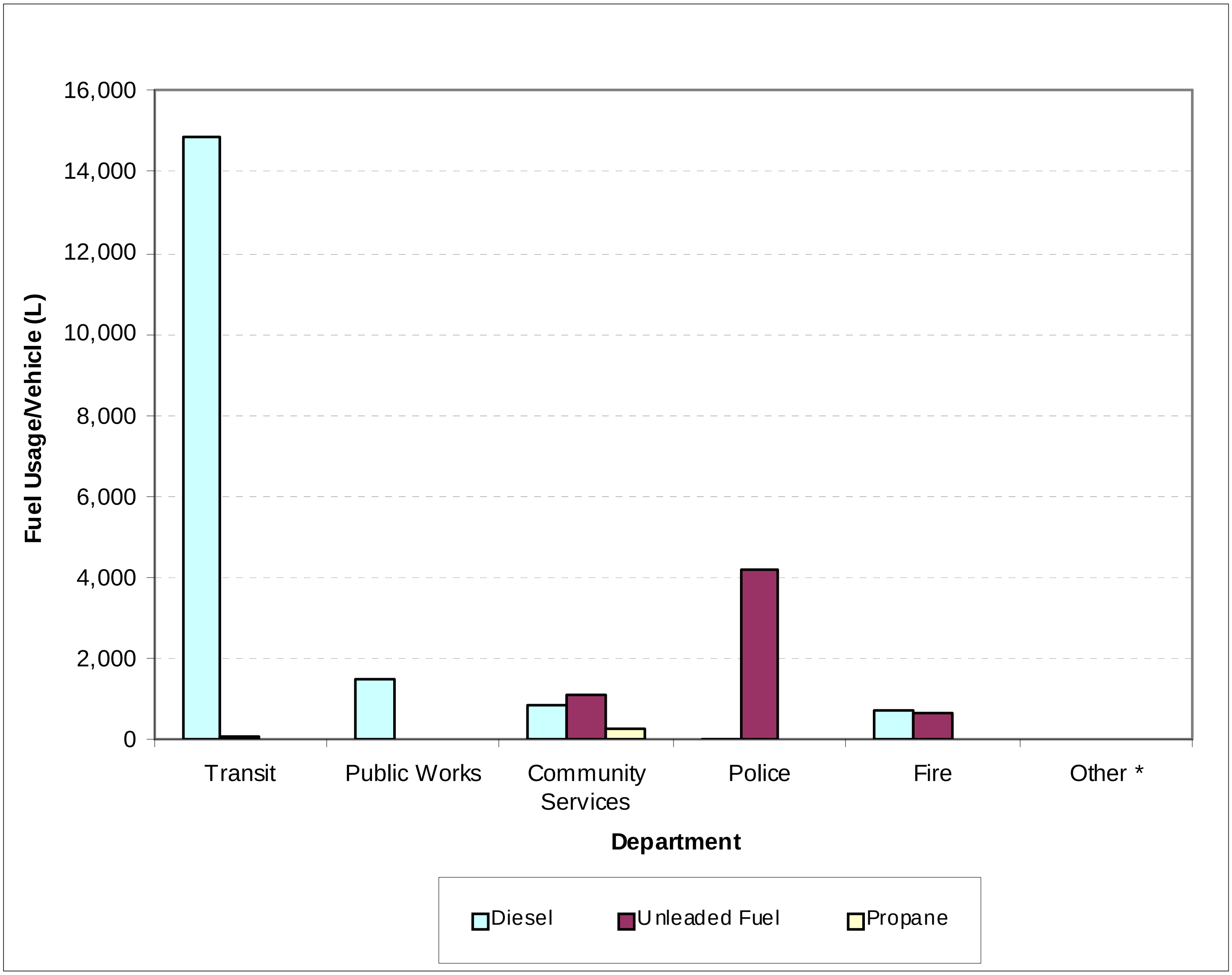
The incomplete data results in a wide range of uncertainty for fuel consumption data. As such, it is currently not possible to determine base efficiency parameters such as average fuel efficiency and total vehicle kilometers driven. The following figures serve as an indication of the relative energy use in each department and class.

FIGURE 1-3
ANNUAL FUEL CONSUMPTION



*No data available at time of report

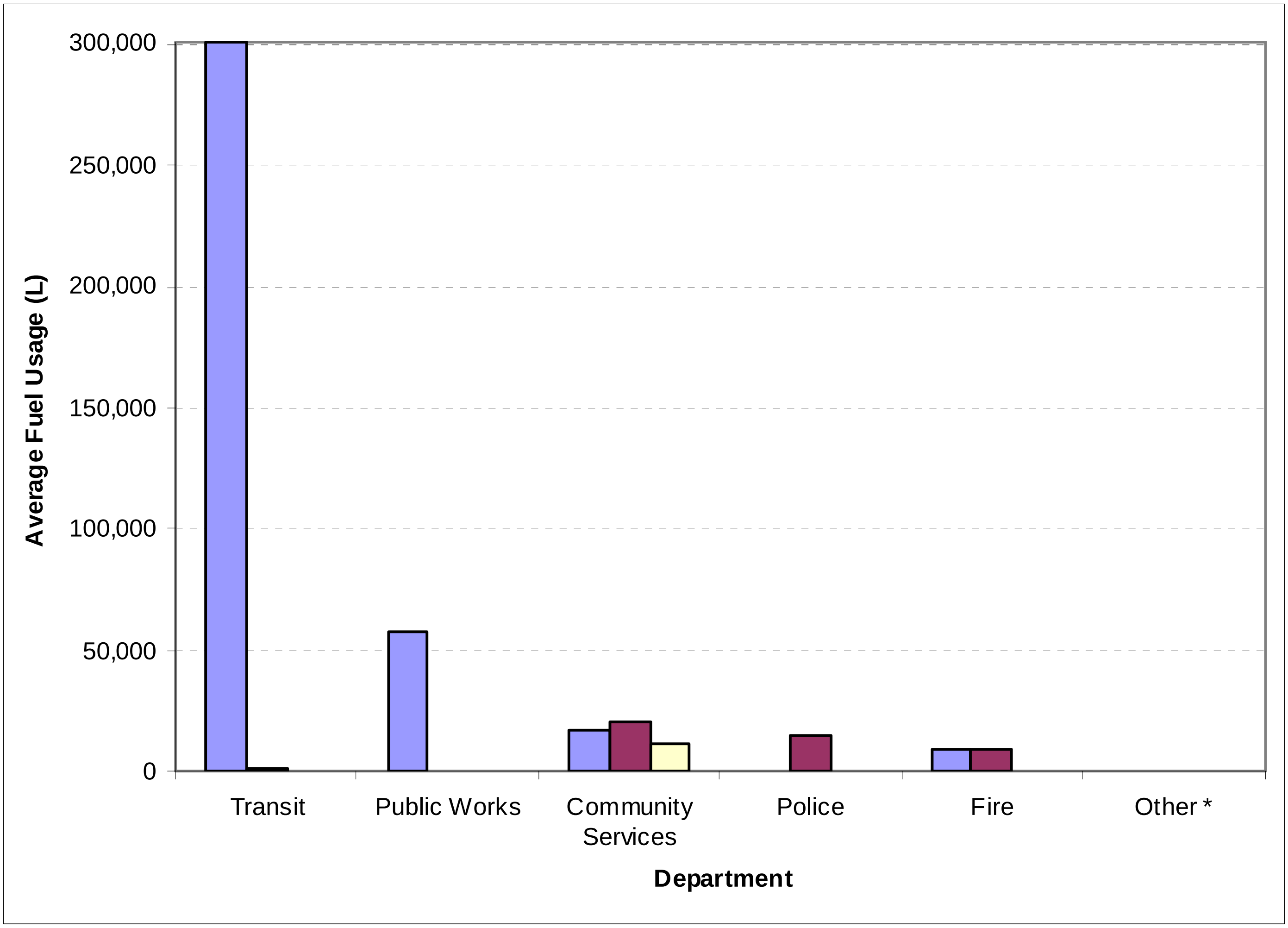
FIGURE 1-4
FUEL CONSUMPTION PER NUMBER OF VEHICLES IN EACH DEPARTMENT



**No data available at time of report*

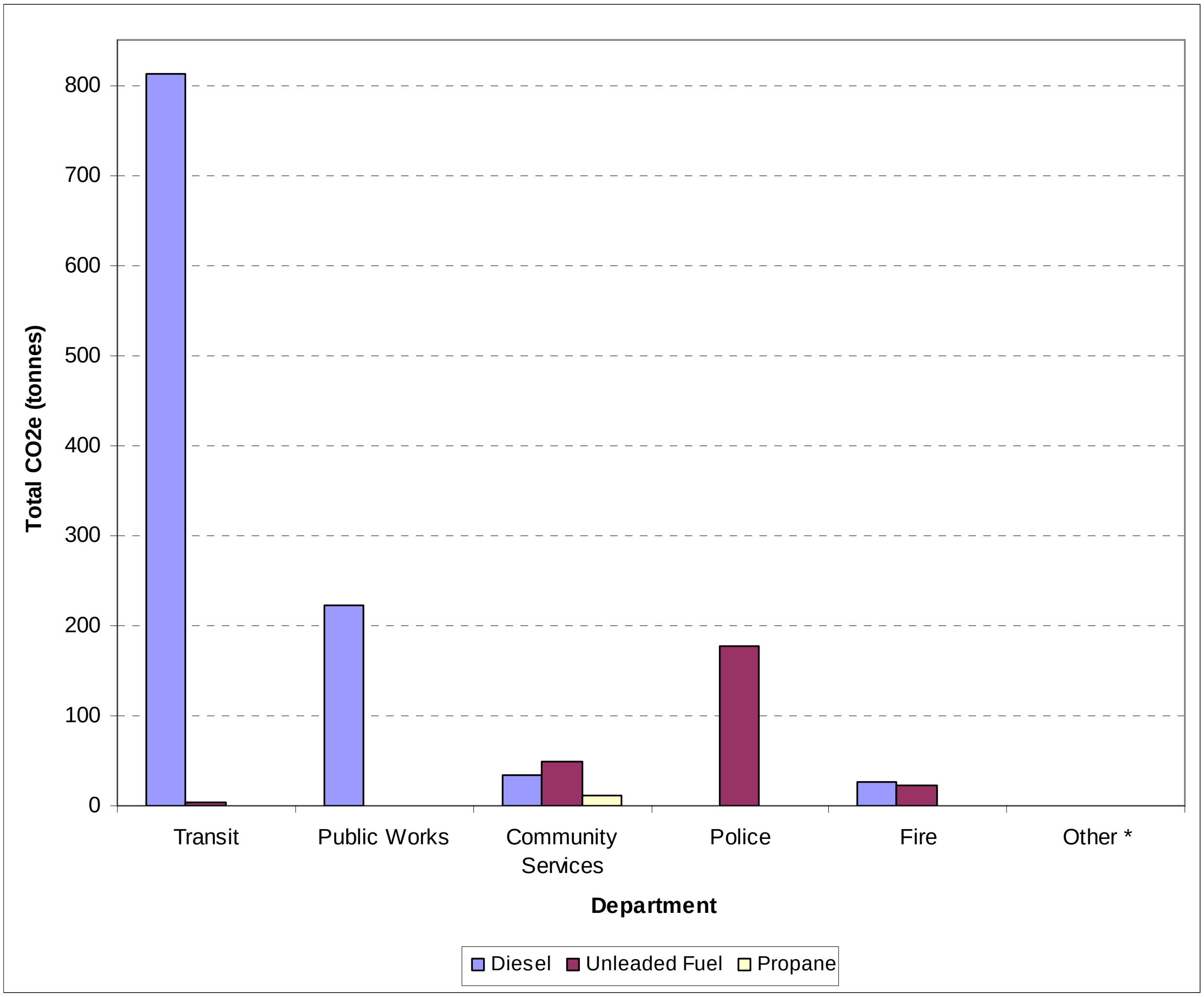
Annual CO2e Emissions

FIGURE 1-5
ANNUAL VEHICLE EMISSIONS CO2E IN 2005



*No data available at time of report

FIGURE 1-6
VEHICLE EMISSIONS CO2E PER NUMBER OF VEHICLES IN EACH DEPARTMENT



*No data available at time of report

While the above Figures 1-4 and 1-5 have a wide range of uncertainty they illustrate trends that support the development of a more rigorous fuel monitoring system. Points of consideration include:

- The Transit Department annual fuel usage is greater than all other classes. This is particularly relevant to the type of vehicles (Series 600-6000) used.
- Each vehicle consumes approximately 5-7% of the department total fuel consumption despite purpose of use and department. As such, small energy efficiency improvements in each vehicle could result in significant energy savings. Usage patterns and idling times of this equipment need to be further monitored to identify energy use reduction opportunities.

Fuel Consumption and GHG Emission Reduction Targets

Table E1-1 indicates the overall increase in fuel consumption between 2004 and 2005 to demonstrate a trend increase. Note there is a level of uncertainty in the data as fuel consumption values from the Police Department are not available prior to 2005; values from the Police Department in 2005 have been omitted in the numbers in parentheses for better comparison. There was a significant increase is the consumption of unleaded gasoline from 2004 to 2005. Due to a lack of available data in the baseline year, the reduction target has been chosen to be 20% of 2005, the year with the most available data.

TABLE 1.1
ANNUAL FUEL CONSUMPTION AND REDUCTION TARGETS FOR FLEET SERVICES

Fuel Type	Annual Fuel Consumption (L)		Percent Increase	2004 CO_2e (tonnes)	2005 CO_2e (tonnes)	Reduction Target CO_2e - 20% Reduction from 2005 (tonnes)
	2004	2005				
Total Diesel	366,205	416,269 (416,183)*	14% (14%)	999	1,096 (1,095)	876
Total Unleaded	26,199	122,379 (47,012)	367% (79)	63	252 (74)	201
Total Propane	25,880	7,499 (7,499)	-71% (-71%)	23	11 (11)	9
TOTAL	**418,284**	**546,146 (470,693)**	**31% (13%)**	**1,085**	**1,359 (1,180)**	**1087**

*Please note, values in parentheses exclude fuel consumption from the Police Department. This provides a better basis of comparison with 2004 values.

If a reduction target of 20% from 2005 values is assumed to be evenly distributed across all sources, then the new CO_2e reduction goal would be 1087 CO_2e tons for all City managed vehicles.

2. Review of Fleet Operations and Energy Efficiency Opportunities

The review of energy efficiency opportunities will be divided into the following categories for this report:

- Behavioural Opportunities, which are further categorized as:
  - Monitoring/Accounting/Benchmarking
  - Education/Driver Habits
  - Usage/Route Optimization,

- Equipment Based Opportunities, which include:
  - Vehicle Type and Size
  - Fuel Type
  - Maintenance
  - Energy Efficiency Devices
  - Energy Efficiency Rebate Programs

Behavioural Opportunities

Fleet Monitoring, Accounting and Benchmarking

Each department implements their own fuel and mileage monitoring system. Some of the departments system is described in detail below:

Fire Department
There is a 10 year turnaround for light cars and a 15 year turnaround for fire trucks.

Maintenance is contracted. Safety checks are performed on a yearly basis.

Police Department
The police fleet consists of 13 vehicles. An emergency RV is run on diesel while all other vehicles are run on gas. Gas is provided by Fire Hall; at the end of each month the Fire Hall invoices the Police Department.

Mileage is recorded by officer. They manually record their times and kilometers on a mileage sheet which is forwarded to duty sergeant at the end of the day. On average each police cruiser consumes half a tank of gas (80L) per day.

Cars are purchased every 2 years, with the current oldest vehicle being at 2 years old. The department is restricted to buying certain vehicles, as mandated by legislation. Cost and safety are the two biggest factors in choosing a new vehicle.

Public Works
Heavy construction vehicles over 2 tonnes are run on diesel. Fuel and mileage are recorded and kept daily. The monitoring system is not computerized. Maintenance is conducted at

the Public Works own maintenance garage. The department had a propane fleet, but this program ended in 2000.

Currently the department is looking into Hybrids to substitute their mid-sized vehicles.

Community Services

A biodiesel fuel program was implemented simultaneously with the bus biodiesel program. 50 Mi trucks used a 20% biodiesel blend in the summer and a 5% biodiesel blend in the winter. There were no adverse issues with the trucks on the biodiesel but the program ceased.

Mileage and fuel are monitored daily. Vehicle operators are obligated to fill out daily reports and inform supervisor of fuel usage every time the vehicle needs to be filled up.

The garbage trucks implement a route optimization program. There are specific route runs to limit drive time. Other vehicles use is limited.

Education and Driver Habits

Each department has a different driver training program for vehicle operators. At present, these training programs are primarily directed at improving road safety and increasing driver qualifications to operate the larger 5 ton diesel vehicles. The program does not address environmental issues and how to mitigate the impacts by modifying driving habits.

Vehicle Idling

Vehicle idling can be a huge operating cost for fleet operators. The city currently has an anti-idling bylaw (Idling Control By-law 133-2001) in place to curb vehicle idling. The by-law states that no person shall cause or permit a vehicle to idle for more than five consecutive minutes.

Idling is often done in winter for vehicle heating. The by-law does not apply to vehicles when the ambient is more than 27° C or less than 5° C. With respect to snow removal equipment, engines are left idling to power lights for safety reasons and to keep the cab warm to prevent snow build-up on the windows (it is felt that defogging windows and clearing snow during restart may use more fuel).

Equipment Based Opportunities

Vehicle Type and Size

With respect to vehicle purchase in general, vehicles are chosen based on solely on costs and safety. Emission efficiency is not a factor in the purchasing decision.

Fuel Type

As noted earlier, the majority of light duty vehicles are gasoline as they are generally lower in capital cost. Mid-sized vehicles are a mix of gasoline and diesel depending up on the expected duty. Diesel is preferred for higher duty applications because it offers lower long term maintenance and operating costs. Heavy duty vehicles are all diesel since existing gasoline engines do not have sufficient power.

Alternate fuels have been evaluated by various departments but higher maintenance costs and fuel availability have plagued the expanded use of fuels such as CNG, LPG, ethanol and biodiesel.

Compressed Natural Gas (CNG)

CNG currently represents the greatest economically viable opportunity to significantly reduce GHG emissions from Stratford's fleet vehicles. An equivalent litre of CNG produces 16 percent the GHG emissions of gasoline and 14 percent the GHG emissions of diesel. This reduction is achieved since natural gas is a saturated fuel – put another way, the carbon atoms in natural gas have the maximum number of hydrogen atoms attached resulting in the highest percentage of energy coming from the production of water as opposed to CO_2.

<u>GHG Reduction Potential of CNG</u>

If 50 percent of Stratford's Class 100 Vehicles were converted to natural gas and it is assumed 50 percent of gasoline consumption would be converted natural gas - an overall reduction of 17 percent in the fleet's total GHG emissions would be realized. (This reduction includes all diesel and gasoline emissions – excluding transit.)

For CNG to be economically viable three main factors must be addressed: refueling infrastructure, vehicle conversion cost and fuel and maintenance costs.

<u>Electrical Compressor Energy for CNG Refueling</u>

A 100 HP compressor generates 5.66 m3/min of CNG
1m^3 of CNG is equivalent to 1.07 litres of gasoline
Therefore 5.66m^3/min ÷ 1.07 litre/m^3 = 5.28 litres/min of gasoline equivalent
100 HP operating for 1 min = 1.26 kWh
1.26 kWh = 6.4×10^{-5} Tonnes CO_2e
Based on Ontario's current electricity mix compressor energy results in less than a 1% change in the GHG emission reduction benefit between natural gas and gasoline.

While past difficulties have existed with natural gas vehicles, the industry has made significant advances both in vehicle conversion technology and refueling systems. Partnerships can be made with natural gas companies, such as Enbridge Inc., to develop a flexible on-site refueling system that could be leased as an embedded fuel cost. Compressor options could range from a fast fill system, individual vehicle refueling appliances (slow fill) or a hybrid system offering accelerated refueling times. The compressor of choice could be continually upgraded depending upon the number of vehicles converted to natural gas.

Over the last several years significant research and development has been conducted on natural gas conversion kits for passenger vehicles, pick-up and vans. New fuel injected conversion kits allow for highly reliable operation of dual-fuel vehicles. Of course the dual fuel capability eliminates any issues with respect to vehicle range.

Bio-Fuels – Ethanol Blends

Ethanol is produced from renewable biological feedstocks, such as agricultural crops and forestry by-products. It acts as an oxygenate in fuel improving combustion and reducing overall emissions.

Ethanol-blended fuels as E10 (10% ethanol and 90% gasoline) reduces greenhouse gases by up to 3.9%. Ethanol blends are available through many retailers throughout southern Ontario including all Sunoco outlets, Pioneer Petroleum, Mr. Gas, Sunys and UPI Inc. Setting a purchasing policy based on the use of ethanol blended gasoline would generate a GHG reduction of 4 percent of all gasoline emissions, however, there is currently some debate as to whether there is a net benefit to GHG reductions when considering the ethanol fuel production lifecycle, which may create some public criticism from residents.

Bio-Fuels – Biodiesel

Biodiesel is a produced from a chemical reaction between methanol and oil from soybeans and or from food waste products such as animal fat. Biodiesel can be used directly or as a blend with petroleum based diesel fuel. Typical mixtures are an 80/20 mix (80% petroleum based and 20% biodiesel fuel), or a 50/50 mix (50% petroleum based and 50% biodiesel fuel).

Biodiesel produces less harmful emissions of most air pollutants and also has the benefit of being biodegradable. While biodiesel has more lubricating ability than petroleum diesel and can reduce engine wear, it also has a higher viscosity and can clog fuel lines during cold weather operation. The City of Toronto has done extensive testing on the operation of vehicles with 100% biodiesel during summer months and has found very positive results. Biodiesel vendors will typically offer special blends for fuel supply during colder months. There are select public outlets selling biodiesel, but in general the fuel is purchased and stored on-site – vendors will also supply on-site storage containers. Vendors have advanced the consistency of their blends to optimize vehicle operation.

According to emission factors developed with Natural Resources Canada, the Canadian Agricultural New Uses Council (CANUC) has published the following greenhouse gas emission rates for biodiesel from different sources based on CO_2e/L listed in Table 2-1.

TABLE 2.1
BIODIESEL EMISSION FACTORS

Biodiesel Emission Factors	
Regular Diesel	3.12 kg
Soybean Based	1.27 kg
Canola Based	1.25 kg
Recycled Cooking Oil	0.71 kg
Animal Fats	0.29 kg

Note: Based on Life Cycle – not tailpipe emissions

As indicated by the above table, the application of 100% biodiesel can reduce GHG emissions by 60% or greater.

GHG Reduction Potential of Biodiesel

If Stratford operated summer months on a 20 percent biodiesel blend and on a 5 percent blend during winter months this would result in a 10 percent reduction in GHG emissions attributable to diesel fuel usage. This would represent a net reduction in CO2e emissions of 119 tonnes which is 30 percent of the fleets PCP target of 394 tonnes.

It should be highlighted, that unlike CNG, biodiesel does have a slight fuel cost premium. However the Provincial Government has eliminated the fuel tax on biodiesel (14.3 ¢/litre) and the federal excise tax of 4 cents per liter was eliminated in the 2003 federal budget – thus reducing the fuel cost premium to about 1-2¢/litre. Biodiesel cost can be subject to fluctuations based on agricultural commodity prices and inventories – especially for soybean based biodiesel. Companies such as Biodiesel Canada manufacture the fuel in Canada from recycled cooking oils and animal fats allowing for a more stable price regime. (Biodiesel Canada offers a 5 percent biodiesel blend for the winter and a 20 percent blend for the summer months.)

Fuel Options for Stratford Transit

Most major bus fleets across North America are now adopting CNG as a major portion of their new fleet stock – in fact 25-30 percent of all new bus purchases are CNG dedicated. New engine and compressor technologies have made these buses very reliable and an environmentally friendly alternative to diesel. For the City of Stratford, however, one challenge impedes that adoption of natural gas buses which is the relatively low turn-over rate. There are generally a minimum number of buses that must be dedicated to natural gas before the lease of a compressor system can be economically justified. For CNG to be a viable option the City would need to incorporate the requirement to operate CNG buses in it tender documents. However, taking account fuel savings and emissions reduction, which is 40%, the conversion of CNG is beneficial in the long term.

As another alternative, biodiesel as fuelwill reduce GHG emissions as well as other hazardous emissions such as diesel particulates. The City of Brampton is currently running its fleet on biodiesel as well as the City of. A comprehensive test of biodiesel was conducted by Société de Transport de Montréal (STM) and the Canadian Renewable Fuels Association. The results of this testing are available online at www.stm.info.

Blending Low Sulphur Diesel Fuels

Sulphur acts as a lubricant in diesel fuels and low sulphur fuels can tend to accelerate engine wear. Testing has found that the lubricity of biodiesel enhances engine lubrication and has been proven to increase mileage.

Biodiesel offers a low capital cost option for the City of Stratford to significantly reduce emissions from its entire diesel fleet. Operating on a 20% blend would reduce GHG diesel emissions by 16 percent as compared to running straight petroleum based diesel.

Maintenance

Each department should implement a very maintenance program that ensures all vehicles are operating at peak efficiency. The maintenance program should include a certified emissions testing centre for both gasoline and diesel engines which allows all vehicles to be routinely tested to verify peak operating performance. In addition to engine tuning, other routine maintenance such as regular checks on tire pressure and alignment also helps to ensure maximum vehicle mileage per litre of fuel.

Summary of Measures

Based on the preceding behavioural and equipment based measures, a 20 percent reduction in GHG emissions for Stratford's entire fleet should be attainable. It is interesting to note that CNG is currently the only measure that offers greater than 20% reduction of 2005 emissions in GHG emissions on its own. To achieve the overall target of 20% reduction by 2014 the City will need to implement both behavioural and equipment based measures to meet the target.

Tables 2-2 and 2-3 provide a summary of goals and potential measures that would need to be achieved to meet the reduction target of 1087 tonnes CO_2e by the year 2014.

TABLE 2.2
SUMMARY OF GHG EMISSION REDUCTION GOALS

Department	Reduction Amount (20% of 2005 Total Emissions) (tonnes CO2e)	Reduction Target for 2014 (tonnes CO2e)
Transit	163	653
Public Works	45	178
Community Services	19	75
Police	36	143
Fire	10	38
Other *	-	-
Total	272	1,087

* There is no data for vehicles in the Other category.

TABLE 2.3
SUMMARY OF GHG EMISSION REDUCTION MEASURES

	Fleet Services Behavioural Factors	Potential CO_{2e} Reduction (tonnes)
1	Smart Driver Training Program	
	This measure encompasses all aspects of Smart Driver training including minimization of idling, trip optimization and better fuel use accountability. Current experience from this program has demonstrated that 8-10% fuel reduction is achievable if awards recognition programs are in place. This measure is applicable to all fuel usage.	122
Fleet Services Equipment and Fuel Use Factors		
2	Conversion of 50 Percent of Series 100 Vehicles From Gasoline to Natural Gas	
	CNG offers an 84% reduction in GHG emissions as compared to an equivalent amount of gasoline. Conversion to CNG offers the highest percentage reduction option currently available to Fleet Services.	268
3	Use Ethanol Blended Gasoline for Remaining 50% of Series 100 Vehicles Running of Gasoline	
	Ethanol blended gasoline can reduce GHG emissions by approximately 4%.	13
4	Switch to Blended Biodiesel	
	Significant test data is now available on the operation of biodiesel in various types of vehicles ranging from pick-up trucks to garbage collection vehicles and transit buses. Suppliers indicated a confidence level in converting fleets to a 20% summer blend and 5% winter blend of biodiesel. The GHG emission reduction presented in this measure assumes a yearly blended average of 12.5% biodiesel.	102
Stratford Transit Behavioural and Equipment Factors		
5	Switch Transit Buses to Biodiesel	
	Comprehensive test data is now available from testing completed by Société de Transport de Montréal (STM) and the Canadian Renewable Fuels Association. As noted in the fleet section, a blended fuel average of 12.5% annually provides the opportunity to reduce equivalent diesel emissions by approximately 10%	140
TOTAL		**640**

Note:

The measures in Table 3 are considered mutually exclusive for illustration and are not considered in combination. That is, behavioral factors reducing overall fuel use will affect the potential of equipment based measures.

APPENDIX C

CITY OF STRATFORD CORPORATE ENERGY PLAN
REVIEW OF ENERGY EFFICIENCY OPPORTUNITIES
MODULE C – LANDFILL AND SOLID WASTE

City of Stratford Corporate Energy Plan

Review of Energy Efficiency Opportunities

Module C:
Landfill and Solid Waste

Prepared for

City of Stratford

Prepared by

CH2MHILL

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1. Review and Profile of Waste Management

Background

This document is intended as a sub component to Stratford's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its commitment to the Federation of Canadian Municipalities' (FCM) Partners for Climate Protection Program (PCP program). The recommended greenhouse gas (GHG) reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 2003 energy use levels, by the year 2014.

Waste Diversion

The City of Stratford owns and operates The City of Stratford Landfill operated under the Ministry of Environment (MOE) Certificate of Approval No. A150101. The landfill site is approximately 45 hectares, located on Lots 4, 5 and 7, Registered Plan 370, City of Stratford, part of Lot 44, Concession 2, Township of South Easthope. The landfill site municipal address is 777 Romeo Street South. The northern area of the site has been receiving wastes since 1952, but the Certificate of Approval No. A150101 was not issued for the entire site until the 1970s. The site operates from Monday to Saturday, between the hours 08:00 and 19:00.

Currently the landfill receives residential waste, industrial, commercial and institutional (ICI) non-hazardous wastes generated within the City; demolition materials; street sweepings; and dewatered sewage sludge from the City of Stratford Water Pollution Control Plant. The site has also been approved for the transfer and processing (such as sorting and recycling) of separated fractions of domestic, commercial and solid non-hazardous industrial waste. In an effort to reduce the quantity of waste disposed of at The City of Stratford Landfill, the City has developed several waste reduction and waste diversion initiatives over the years, which are described later in this module.

In 2005, the City of Stratford generated 104,744 tonnes of solid waste materials; this amount includes all wastes streams such as asphalt fill, recyclables collected at curbside, leaf and yard wastes, metals as well as wastes that were received at the landfill. Of this 104,744 tonnes of waste, 24,661 tonnes were considered Municipal Solid Waste (MWS) and was landfilled. 325 tonnes of the MSW was produced by the City's corporate buildings; waste generate by City corporate buildings will be further referred to as Corporate Wastes.

Figure 1-1 shows the amount of waste landfilled between the years 1991 to 2005. Overall, the amounts of wastes landfilled have decreased over the years, remaining relatively constant in the last decade.

FIGURE 1-1
STRATFORD WASTES LANDFILLED BETWEEN THE YEARS 1991 TO 2005

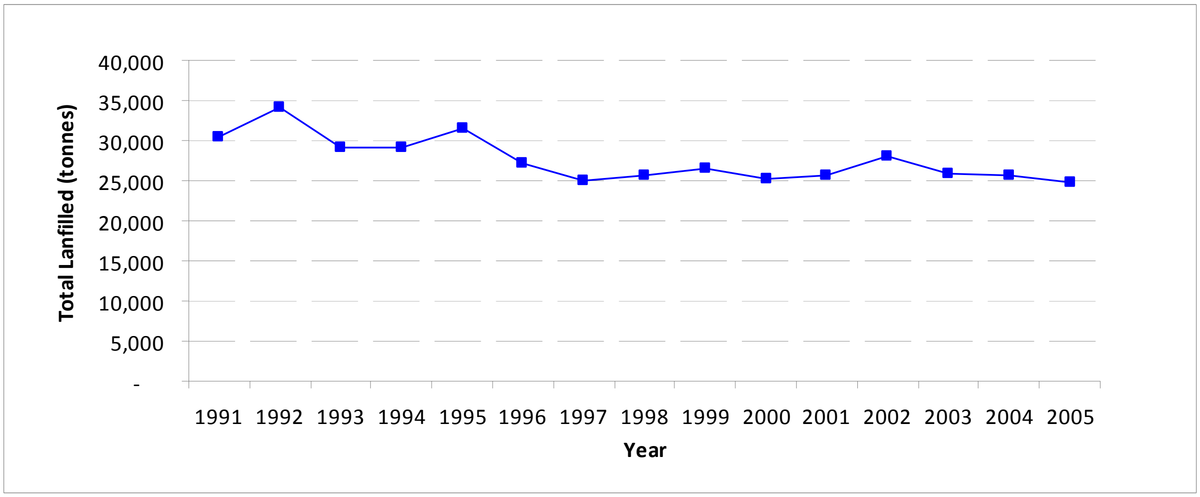


FIGURE 1-2
STRATFORD WASTE TRENDS

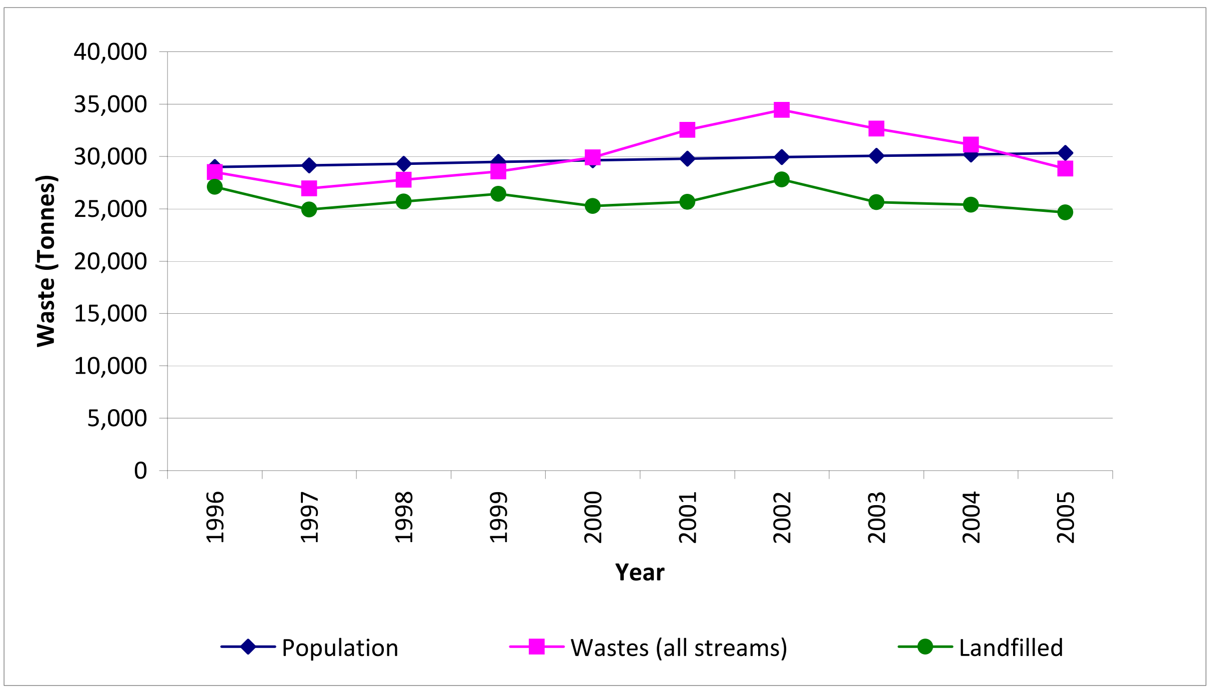


Figure 1-2 illustrates the trends in waste generation, waste landfilled, and population. There does not appear to be a correlation between wastes generated and population increase. The total wastes generated by the City increased during the late 1990s and began to decline slightly in the more recent years. Looking at Figure 1-2, there appears to be approximately 2,000 tonnes of waste generated more in 2002 than in 2001 and 2003. This significant difference which is partially attributed to an error in the landfill waste records. In

March 2002 approximately 735.84 tonnes of old wood chip material were coded as new waste in the landfill inventory. The increase is also accounted for in a surge of residential wastes in August of 2002 and Public Works wastes in March 2002.

The City initiated waste reduction efforts in the 1970s with a newspaper and a glass recycling collection depot. In 1987, the curbside recycling program was introduced, which diverted the amount of recyclable materials being sent to landfill by residents. Over the years, the program continued to expand its capabilities to include recycling of the following materials:

- Paper (includes newspaper, magazines, boxboard, office stationary, old corrugated cardboard)
- Steel cans (includes food & beverage cans, bottle and jar lids)
- Aluminum cans & foil (includes food & beverage cans, pie plates and flattened foil)
- Clear & coloured glass (includes food & beverage containers only)
- Plastics (includes PET, HDPE, LDPE)
- Polycoat cartons & aseptic containers.

Residential and commercial recycling collection for 2007 to 2009 is contracted out to Brian Leyser Recycling. Processing of recyclables occur in the Brian Leyser Recycling's Material Recovery Facility located in the City of Stratford. Recycling collection in Stratford is carried out on a bi-weekly basis for residential, and weekly for commercial, high density residential and the downtown core.

In addition to the residential recycling program, the City has implemented several other initiatives with the goal to further reduce waste generation or increase waste diversion. The following list briefly describes these initiatives:

- *Garbage Collection* – Since 1997, Stratford has been using a user pay system for solid waste collection for the purpose of reducing the quantity of solid waste heading to the landfill from the municipal collection system, and to create a more equitable system by which generators pay for the collection and disposal of waste produced. This system funds the City's collection and disposal of solid wastes.
- *White Goods Collection* - Large appliances, or white goods, are collected by the City on a monthly Pay-As-You-Go collection system. Appliances containing, or that may have contained, Freon cost $35 to dispose; appliances that do not contain Freon cost $22. The City collects the appliances recycled,or repaired. Appliances containing or having contained Freon are not accepted at the landfill site.
- *Asphalt and Metal Collection* - The City of Stratford also separates concrete, asphalt and metal from the waste stream. The concrete and asphalt materials diverted are used internally for road reconstruction within the landfill. Asphalt shingles are also being diverted from disposal at the landfill site. There are no records of the amount of wastes diverted as a result of this program prior to 2000.

- *Electronic Waste Recycling -* In 2007, the City of Stratford banned electronic waste from entering the landfill. Residents and businesses are encouraged to dispose of old electronic equipment with a local electronic-waste recycling company.
- *Yard Waste Collection -* Throughout the spring, summer and fall, Stratford operates a yard waste collection program. Hedge trimmings, tree prunings, leaves, weeds and yard plants are considered yard wastes, and can be bundled in bags for disposal. There is a limit of bags per household per collection. Bags are collected at curbside during scheduled pick-up dates and are taken to the landfill compost site. Grass clippings and household organics are currently not accepted as part of curbside collection. The yard waste collection program began in 1994; at that time, wastes were dropped off at the landfill site in designated areas. In 1998, the curbside collection of leaf and yard waste was initiated. There are no records of the amount of wastes diverted as a result of this program prior to 2000.
- *Composter Program –* Residents can purchase composters from the City to compost household organics in their backyards. Because this program is performed by individual residents in their own home, there are no records as to how much waste is diverted as a result of the composter program. This program was implemented in 1992.

As a result of these waste diversion programs, the amount of wastes diverted from the landfill has increased significantly over the years. Figure 1-3 shows the steadily increasing diversion of wastes from the landfill. Figure 1-4 shows the amounts of different types of wastes diverted from the landfill. Though waste reduction efforts commenced in the 1970s, there are no records of the amount of wastes recycled or total wastes generated prior to 1996. There is also no data for metals and asphalt recycled, or materials composted prior to the year 2000.

From Figure 1-3, it can be seen that though total waste generated by the City of Stratford has increased from 2000 to 2005, the percentage of wastes diverted from the landfills have also increased, and subsequently, reducing the annual percentage of wastes going to the landfill. Figure 1-4 indicates that curbside recycling, metals recycling and asphalt recycling efforts have increased; however, composted materials have decreased from 2000 to 2005.

FIGURE 1-3
STRATFORD WASTE DIVERSION HISTORY

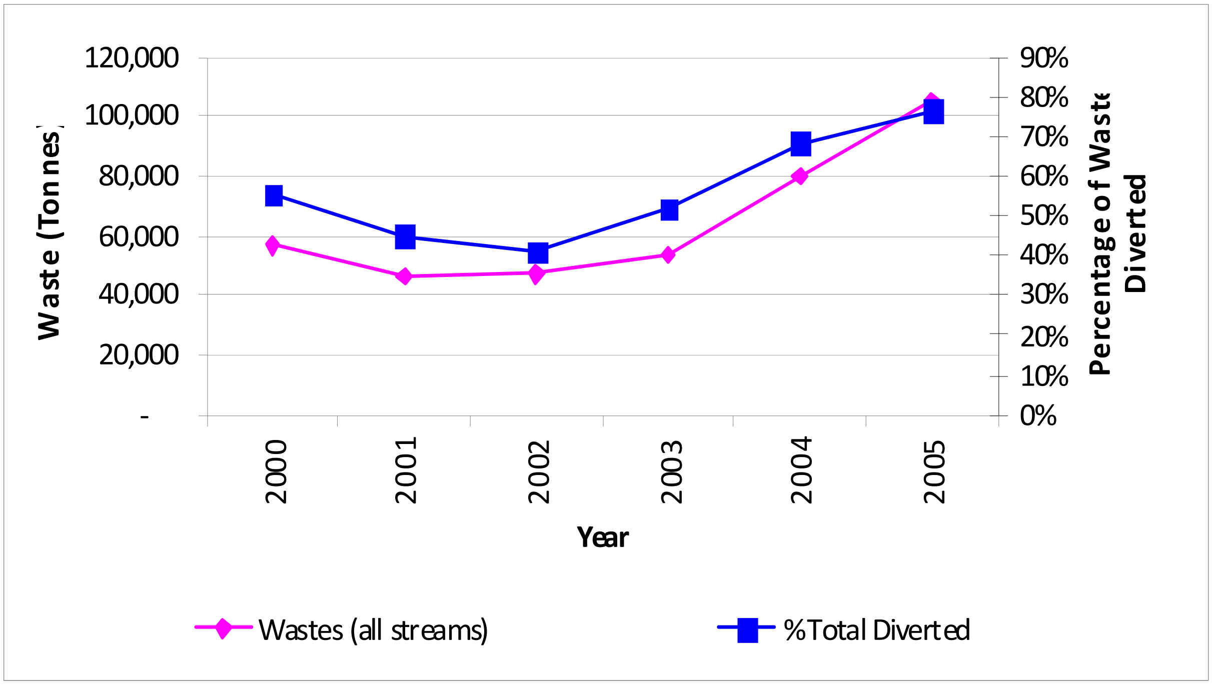
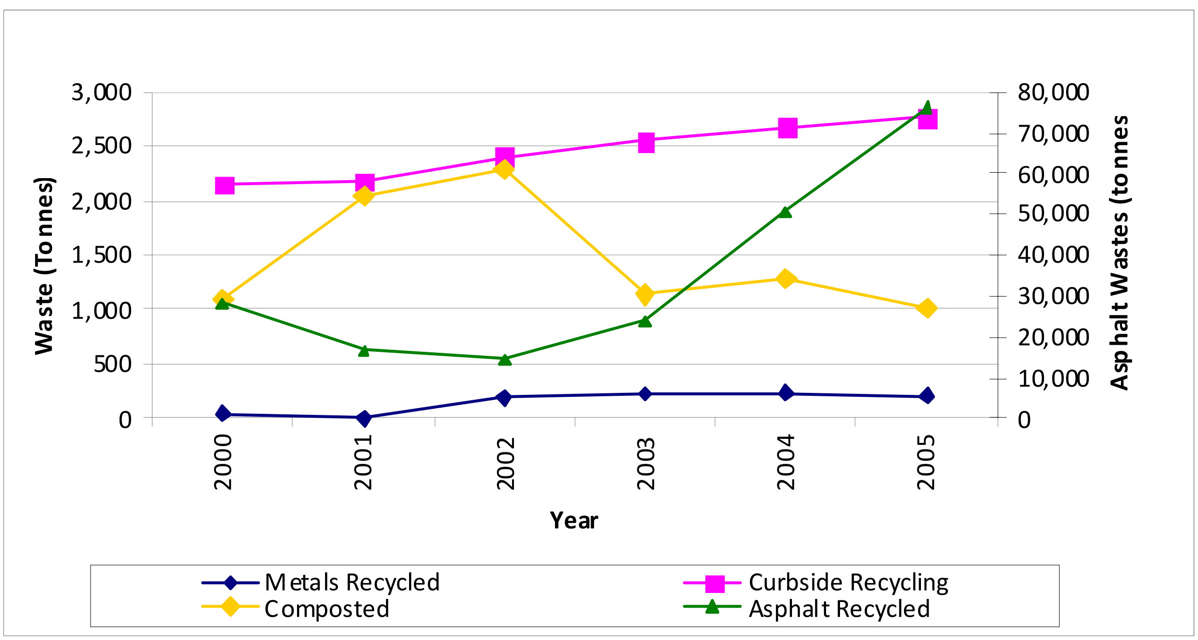


FIGURE 1-4
AMOUNTS OF VARIOUS WASTES DIVERTED FROM LANDFILL



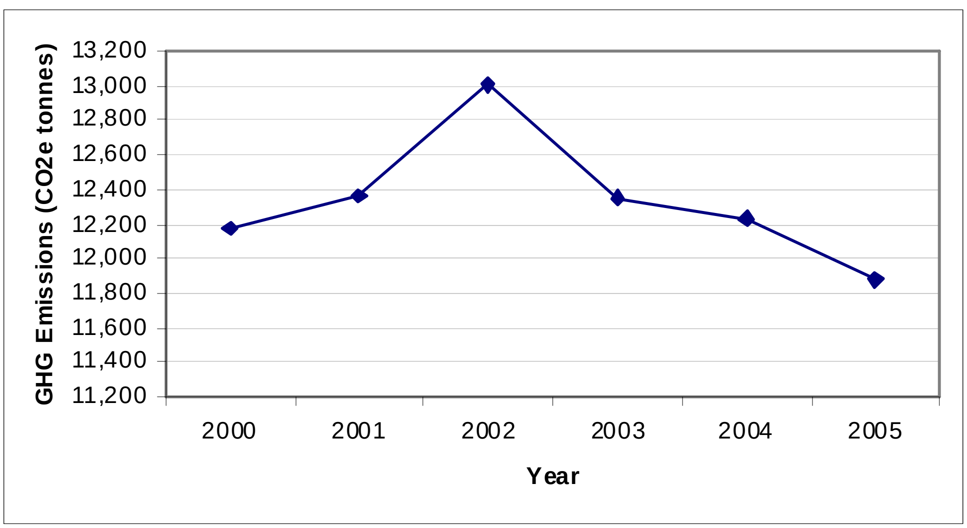
The City has set goals to further divert wastes from the landfill through additional initiatives such as:

- *Wood Waste Diversion –* The City is working on implementation of a full wood waste diversion program at the landfill.
- *Plastic Film Recycling-* This program will provide local businesses with education on plastic film reduction as well as recycling options.
- *Curbside Organics Collection -* In the last tender (for the years 2007-2009) for curbside waste and recycling collection, organics was included and bid on. However, the City decided against introducing a curbside collection program for organics due to cost. The City hopes to be able to collect and compost household organics in the next tender.

In 2003, the City of Stratford generated 12,350 CO_2e tonnes of GHG emissions from landfilled wastes. Corporate wastes generated 183 CO_2e tonnes of emissions; of the total amount of generated emissions, Corporate waste's contribution was less than 2%. Figure 1-5 illustrates that as a result of a reduction in wastes landfilled, GHG emissions have also decreased. There is a significant peak in 2002 due to an abnormally high of residential and Public Works wastes generated in August and March 2002, respectively. The landfill coding error amount was omitted from the data to calculate the generated amount of emissions in 2002.

The total emissions for all landfilled wastes in 2005 was 11,879 tonnes CO_2e; Corporate waste generated 157 CO_2e tonnes. A 20% reduction from 2003 Corporate values is 37 CO_2e tonnes, resulting in a reduction target of 146 CO_2e tonnes for corporate wastes.

FIGURE 1-5
GHG EMISSIONS FROM LANDFILLED WASTES



Landfill Gas Production

The City of Stratford's landfill currently does not have a landfill gas collection system in place. Landfill gas (LFG) is composed primarily of methane, carbon dioxide and trace constituents of sulphur compounds and volatile organic compounds. LFG is produced by the decomposition of waste and is estimated to contribute to over twenty-five per cent of Canada's methane emissions. Technology has been developed to mitigate the amounts of LFG emitted into the atmosphere. The gas can be captured by drilling deep into the site, pumping out the gas through a network of pipes, and flaring the gas. Flaring destroys the methane in landfill gas, and therefore reduces the greenhouse gases (GHGs). Utilization instead of flaring provides additional benefits, including generating revenue at sites where landfill gas utilization is economically viable. The capture of landfill gas provides a source of renewable energy, primarily for heating and generating electricity, but also for new uses such as vehicle fuel.

Methane gas production at the City of Stratford was estimated to determine the potential supply of LFG and is shown in Figure 1-6. The site began receiving waste in 1952 and will receive 25,000 tonnes of wastes annually from 2006 to 2020. Since there is a finite amount of biodegradable material, the amount of gas will decrease over time. Assuming there are no changes in landfill operation and the landfill had a 70% LFG recovery, a minimum of 27,000 tonnes of CO2e per year would be reduced by flaring the gas. Even more could be realized if the gas was used to create energy. The amount of gas capture and flared can be seen in Figure 1-7 from the year 2008 and onwards.

FIGURE 1-6
TOTAL LFG PRODUCTION FOR THE CITY OF STRATFORD LANDFILL

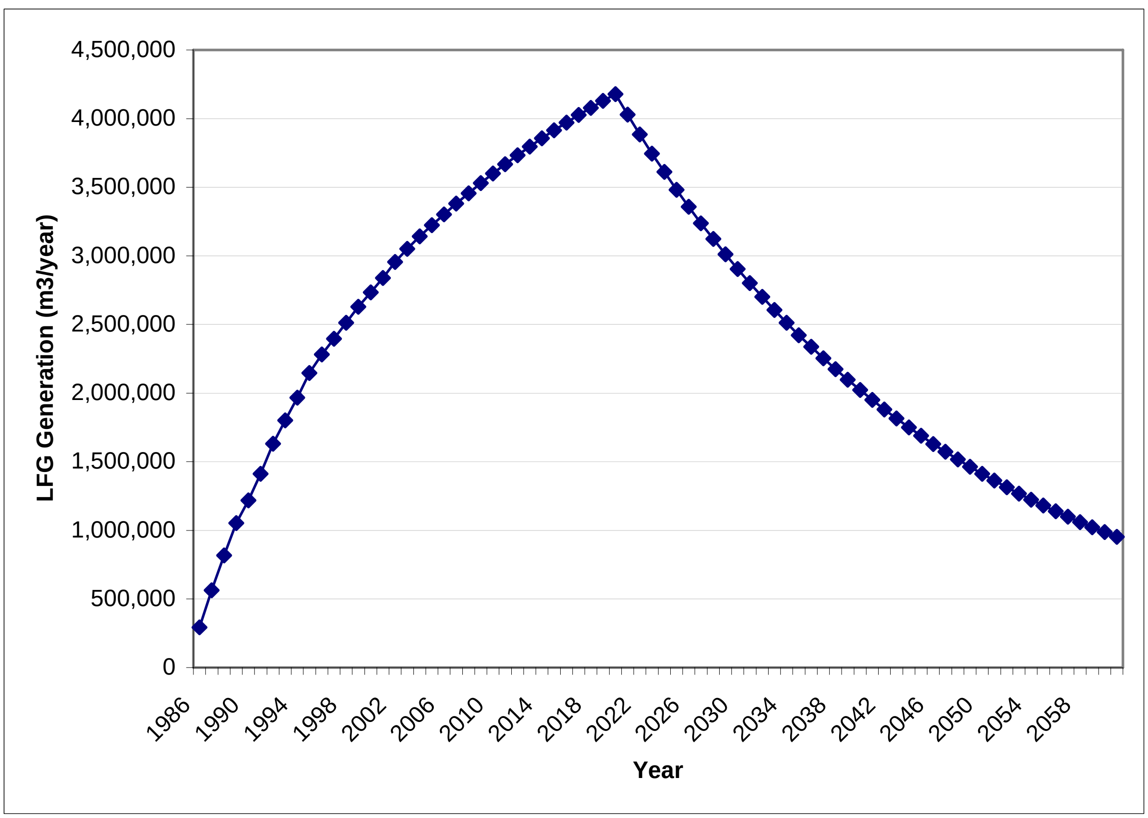
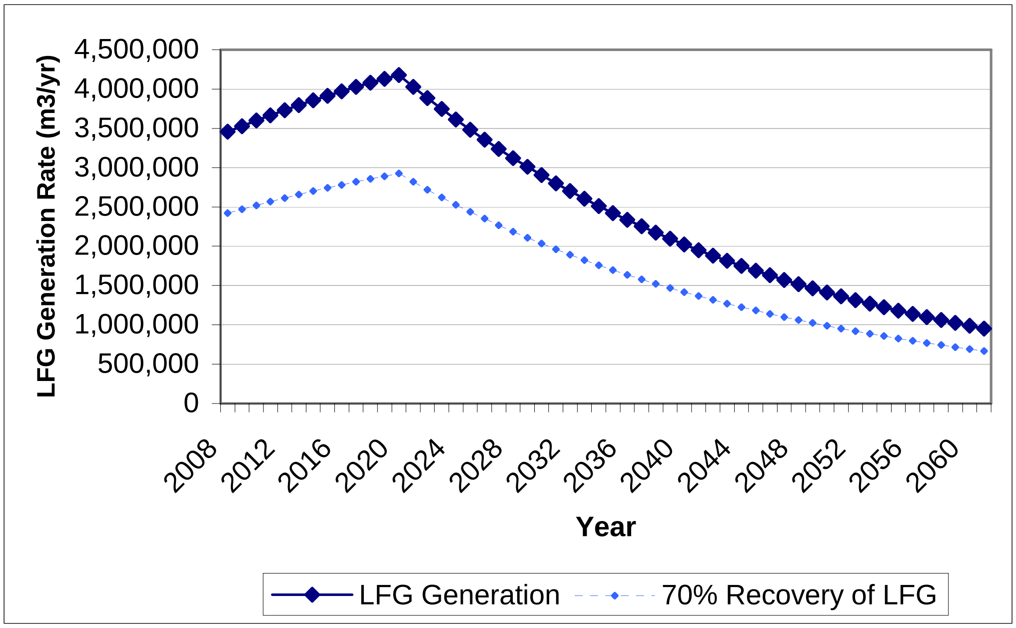


FIGURE 1-7
TOTAL AND 70% RECOVERY EFFICIENCY LFG PRODUCTION FOR THE CITY OF STRATFORD LANDFILL



The term "landfill gas" (LFG) is generally used to refer to the entire mixture of methane, carbon dioxide, and other trace compounds as generated by decomposition of wastes placed in a landfill. The term "landfill methane" is often used to refer only to the methane component of landfill gas.

Landfill Gas Recovery

Typically, flaring LFG could reduce an entire city's total GHG emissions by more than 20%. Assuming there are no changes in landfill operation and the landfill had a 70% LFG recovery, a minimum of 27,000 tonnes of CO_2e per year would be reduced by flaring the gas which could help the City of Stratford meet its reduction targets as set out in the PCP program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 2003 energy use levels, by the year 2014. The flared gas could be recovered and used as alternate fuel within in the city.

Gas Generation Estimation Methodology

Assessment of landfill gas for the purpose of designing a control system should be based on a conservatively high estimate of the landfill gas generation expected for the landfill site to ensure that the capacity of piping, blower and flare components is adequate to accommodate the highest rates of gas generation that could be realized at the landfill. Selection of a control technology and sizing of the integral components of the technology is based primarily on the rate of gas generation. LFG generation estimating techniques are applied to develop a potential range of the LFG generation rates based on site-specific characteristics of the subject site and waste stream. A range of generation estimates is developed by incorporating reasonable variations in the model input parameters to incorporate expected, but unquantifiable, variability within the waste stream and generation processes. The resulting generation range or "envelop" represents the basis for developing the detailed design of the LFG management system.

The generation of landfill gas takes place in stages. Following initial placement of the waste in the site, anaerobic methanogenic decomposition begins following depletion of oxygen in the waste mass. This process generally continues until the organic matter has been fully decomposed. As the landfill ages, the rate of landfill gas generation gradually decreases and the character of trace components in the gas may change somewhat until little or no benefit come from extracting the gas. Thus waste that has previously been placed at the landfill is not suitable for producing extractable LFG for savings of air emissions.

The fundamental elements of landfill gas generation estimates include: the landfill gas yield, the unit landfill gas generation rate, and the site landfill gas generation rate. The landfill gas yield is the total volume of landfill gas produced per unit mass of refuse (i.e., m^3/kg or ft^3/lb.). The unit landfill gas generation rate is the volume of landfill gas generated per unit mass of refuse per unit of time (i.e., m^3/kg/yr. or ft^3/lb./yr.). The site landfill gas generation rate is defined as the volume of landfill gas that is produced by the total quantity of refuse in-place in a site per unit of time (i.e., m^3/hr or ft^3/min.).

A number of important site-specific factors contribute to the generation of gases within a landfill, including:

- *Waste Composition:* The amount of landfill gas produced is dependent on the amount of organic matter in the waste, and the distribution of this matter within the landfill.
- *Moisture Content:* Water is required for the anaerobic degradation of organic matter. The amount of moisture within a landfill also significantly affects the gas generation rates.
- *Temperature:* Anaerobic digestion is an exothermic process. The growth rates of bacteria tend to increase with temperature until an optimum is reached, which is well above average temperatures in temperate climates. The depth of the waste and presence and composition of the landfill cover will impact the extent to which the process is insulated from cooler ambient temperatures.
- *pH and Buffer Capacity:* The generation of methane (CH_4) in landfills is greatest when neutral pH conditions exist. The activity of methanogenic bacteria is inhibited in acidic environments.
- *Availability of Nutrients:* Nutrients required for anaerobic digestion include carbon, hydrogen, nitrogen, and phosphorus, which are generally in sufficient supply in typical municipal solid waste streams to support methanogenic bacteria.
- *Waste Density and Particle Size:* Density of the waste and the proportion of void space also influence gas generation. These both affect the surface area available for degradation and therefore increase the gas production rate. As waste densities increase, the overall porosity is reduced, which in turn reduces the movement of moisture and nutrients through the waste. Layers of low permeability cover soils (or other materials), will also inhibit the distribution of moisture through the waste.

A number of models are available for estimating rates of generation of landfill gas. Accepted industry standard models are generally first order kinetic models which rely on an idealized mathematical representation of anaerobic decomposition and a number of basic assumptions regarding site specific conditions. These models are used to predict the profile of landfill gas generation rates over time for a typical unit mass of solid waste. A theoretical unit landfill gas generation rate curve is then applied to past filling rate data and estimates of future filling rates at a landfill to produce an estimate of gas generation over time.

It should be recognized that site-specific data for many of the variables that effect landfill gas generation are generally unknown and cannot be easily or readily obtained. Furthermore, all of the accepted modeling techniques rely on idealized representations of the landfill gas generation processes that cannot quantify all of the heterogeneous conditions that exist in a landfill site. These factors introduce uncertainties into the landfill gas generation modeling process. One approach that is applied to better understand the possible accuracy of the estimates is to model a number of scenarios varying the possible input parameters within a reasonable range to attempt to gauge the sensitivity of landfill gas generation to the baseline assumptions. Given these limitations, it is recognized that landfill gas generation modeling merely provides an estimate of the landfill gas generation potential, and a fairly wide range of values need to be considered for decision-making for the design of gas management facilities and systems.

The methodology applied in estimating gas generation rates for the City of Stratford Landfill is based on what has become know as the Scholl Canyon model, which is a theoretical first-order kinetics method for estimating landfill gas generation rates, and is of the form:

$$G_i = M_i \, kL_0 \exp^{-(k \times t_i)},$$

where:

G_i = emission rate from the *i*th section (kg CH_4/year)

k = CH_4 generation first order kinetic rate constant ($year^{-1}$)

L_0 = CH_4 generation potential (kg CH_4/tonne of refuse)

M_i = mass of refuse in the *i*th section (Mt)

t_i = age of the *i*th section (years)

The first order decay function is applied to a finite element analysis to develop projections of waste mass as input parameters to estimate landfill gas generation over time. Typical values of k range from 0.02/year for dry sites to 0.07/year for very wet sites. The methane generation potential depends on the waste composition and is directly related to the landfill gas yield. A wide range of values is reported for landfill gas yield extending from 125 m^3/tonne to 500 m^3/tonne (2 ft^3/lb to 8ft^3/lb). This variability is due to variations in the composition of waste used in the various studies of empirical values for the rate constant.

The organic content of waste is responsible for the generation of LFG. Given that municipal waste is a heterogeneous mixture of materials with varying concentrations of organic constituents, input values for the Scholl Canyon model encompass an 'average' value to account for the waste's overall composition.

LFG Recovery Estimate Methodology

Landfill sites equipped with landfill gas management systems have limitations with respect to their effectiveness in recovering all gas generated by the decomposition of organic matter, and some portion of the generated landfill gas cannot be recovered. Design operational status of the site, the presence and composition of cover materials, waste placement techniques, and leachate distribution within the waste mass are all critical influences on the landfill's gas recovery efficiency. Gas not recovered by the management system may be emitted to the atmosphere through the landfill cap, via lateral migration along porous media in the base liner, or through the drainage media and piping of the leachate collection system.

To account for the proportion of gas generated but not recovered, recovery efficiency is estimated for each year that the system is expected to be in operation. The value selected for recovery efficiency is based on the anticipated site conditions and level of development of the LFG management system relative to the estimated LFG generation rate for that given year. In many cases, the efficiency of a system increases as the landfill approaches closure and final capping is undertaken. The development of the site cap provides an effective solution for the City of Stratford further reducing the portion of the landfill gas generated from being emitted to the atmosphere.

Within exceptionally wet landfill sites, where all the pore spaces in the waste are near saturation or where the accumulation of leachate within the waste mass limits the movement of gas through the landfill, the recovery efficiency can be significantly reduced. The excess moisture effectively floods the pathways for gas movement. While engineered solutions are available to reduce the impact of leachate on LFG recovery, such measures can require significant capital and operating costs. Consideration of the leachate distribution within the site must be incorporated into a conceptual model of the site.

2. Management Approach Evaluation

Options available for landfill gas management are summarized in Table 1-1. Descriptions of the management approach options, advantages, and disadvantages of each approach are presented.

TABLE 2.1
LANDFILL GAS MANAGEMENT APPROACH SUMMARIES

Management Approach	Description of Management Approach	Advantages	Disadvantages
No Action	Implement no control measure and allow LFG to passively vent through the landfill cover at the Site	Requires no capital investment or operational costs	Will likely result in nuisance odour impacts off-site; potential dangerous concentrations of methane in soils adjacent to the waste footprint; may result in regulatory infractions; does not reduce air emissions. Can not incorporate utilization technology.
Passive venting and flaring	Passive vents installed at specifically designed locations within the waste mass to provide controlled emission points. LFG emission is driven by intrinsic pressure of LFG generation. LFG can be combusted to significantly reduce methane emissions using individual low flow flares with solar igniters installed at passive vents.	Requires less additional infrastructure and operational investment than active collection. Can be retrofitted to incorporate active gas collection.	Passive vents have low recovery efficiencies and are not reliable for long term operation. Preferential pathways from the waste mass to the atmosphere other than the passive vents may result in uncontrolled emissions and continued nuisance odours. Passive flaring systems do not achieve high operating temperatures required to effectively destroy harmful trace organic compounds commonly present in landfill gas. May not produce enough LFG collection to significantly reduce GHG emissions. Can not incorporate LFG utilization technology.
Active collection and flaring	Collection wells installed within the waste mass to allow controlled collection of LFG as it is generated. LFG is destroyed in a high temperature flare system.	Provides the highest level of control and efficiency for LFG management. Provides the highest probability of successfully reducing odours. Effectively destroys harmful organic trace constituents potentially present within the gas. Successfully reduces GHG emissions, and exceeds reduction targets. Capable of incorporating utilization technology into design.	Collection system requires the highest capital investment and operation costs.

Given the overriding objectives of the PCP program to reduce GHG emissions, the preferred LFG management approach for the Site is active collection with centralized high temperature flaring. Although there is a large initial cost of implementing the system, the future GHG savings would meet the cities reduction needs by 118% from 2002 values by 2014 (refer to Table 1-2).

LFG recovery efficiencies for typical municipal waste landfills are expected to be in the range of 75% to 90% of the total gas generated at the Site. The lowest recovery efficiencies are expected during initial start-up of the system, prior to establishment of final cover on filled portions of the Site. Prior to constructing the final cover, high vacuums cannot be applied to the extraction system mass near the top of the landfill without pulling atmospheric air into the collection system. The introduction of air, and particularly of the oxygen in the air, hampers the operation of the flare system such that high destruction efficiency of the methane and trace organics constituents may not be consistently achieved. If the vacuum is reduced to reduce air infiltration into the waste, the effective zone of influence of extraction wells and/or trenches will be reduced, in turn reducing the overall collection efficiency of the system and increased emissions of landfill gas directly to the atmosphere will likely occur.

As presented in Table 1-2, based on cursory data, the annual GHG reduction could be at least 27,000 tonnes/year. Securing this amount of reduction, the City of Stratford would meet their needs of GHG cutback by 117% by 2014. The peak recovery rates coincide with the peak estimated generation rates. More detailed assessment of the data would be required to model and predict reduction quantities before using these values for formal planning purposes.

TABLE 2.2
ESTIMATED LFG ENERGY RECOVERY & CORRESPONDING GHG REDUCTION POTENTIAL

Parameter	YEAR Unit	2008	2009	2010	2011	2012	2013	2014
Est. Landfill Gas Production	m^3/year	3,456,804	3,529,601	3,599,811	3,667,527	3,732,841	3,795,838	3,856,602
Est. Landfill Gas Recovery (70% of production)	m^3/year	2,419,763	2,470,721	2,519,867	2,567,269	2,612,988	2,657,086	2,699,621
Est. GHG Reduction (CO2e)	tonne/year	27,092	27,663	28,213	28,744	29,256	29,749	30,226

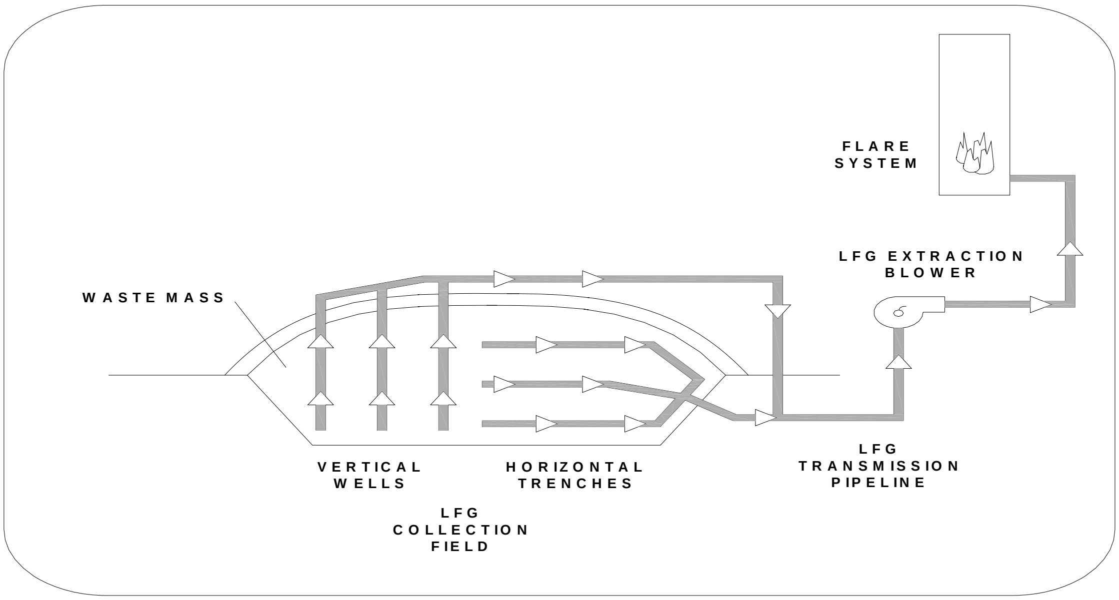
The normal range of recovery efficiencies are based on empirical collection efficiency data typical of active LFG collection systems that are installed and expanded as landfilling progresses. This efficiency range is based on the assumption that vertical wells would be installed in areas of the site that have achieved final grades, and horizontal trenches are installed in the remaining portion of the landfill.

The recovery efficiencies were selected based on a conceptual implementation schedule for a LFG recovery system. Recovery efficiencies are expected to increase as filling progresses and as the final cover is constructed over portions of the landfill that have reached final filling elevations.

Conceptual Design

Figure 2-1 presents a schematic of typical active LFG recovery system components and interconnections.

FIGURE 2-1
ACTIVE LANDFILL GAS RECOVERY SCHEMATIC



Assuming LFG is expected to be generated throughout the operating life of the Site and beyond, the expected LFG generation period is expected to extend more than 20 years. The conceptual design of the LFG collection system includes staged construction and implementation throughout the operating life of the facility. Following closure of the landfill, retrofits may be required to enhance collection of LFG.

The proposed collection system will include both vertical and horizontal collection wells. Incorporating both well types will allow for maximum LFG recovery efficiency and facilitates the integration of the collection system construction with Site operations and for the portion of the site for which filling has been completed, vertical wells are the preferred approach for LFG collection. Vertical wells are installed using conventional rotary auger drilling rigs, commonly used for geotechnical investigations.

Future expansion of the collection field can be accomplished as filling progresses with the installation of horizontal collection trenches. Horizontal collection trenches are typically constructed as filling progresses in actively operated portions of the landfill, eliminating the need to excavate or drill within the waste mass. Horizontal trenches with perforated piping provide high LFG recovery rates and are easily constructed.

LFG Utilization Potential

The methane content of LFG represents a significant potential source of energy. A typical unit quantity of LFG has an energy value of approximately half that of the same quantity of natural gas given that LFG consists of only approximately 50 percent methane. Utilization of the energy content of LFG is currently practiced at numerous landfill sites across Canada. The demand for innovative sources of renewable energy over the past 20 years has been a driving factor in the development and advancement of LFG utilization technologies. However, the potential for LFG utilization is site-specific and very much dependent on the availability of a local end-user that can utilize the gas on a relatively continuous long-term basis, as well as economic factors associated with the capital investment required to extract the LFG and develop and construct the utilization system.

Common full-scale LFG utilization projects in Canada include: generation of electricity, direct use as an industrial process fuel, and direct use as a space-heating fuel. The feasibility and selection of a utilization process must be based on a detailed assessment of the LFG quality, available utilization options, and estimated capital costs versus estimated revenues for the life of the utilization project. Additional factors, unrelated to technical and economic considerations, such as public support or opposition, are also critical factors that may influence the evaluation of available utilization approaches.

Based on the estimated LFG generation rate, utilization may be practicable at the Site. Potential utilization approaches appropriate for the estimated LFG recovery rates may include generation of electricity using reciprocating engines, or direct use of LFG as a heating fuel pending identification of a long-term local user.

Typical ‘yard stick’ recovery rates required to support the generation of electricity from LFG based on the fuel requirements of current generation reciprocating engine technology are between 300 and 375 cfm per megawatt (MW) of electricity generated. It should be noted that power generation often requires the removal of trace compounds commonly found in raw LFG. Trace compounds such as siloxanes and sulphides can significantly shorten the service life of critical components of reciprocating engine generator sets. Detailed characterization of the LFG is required to determine if gas treatment in addition to moisture removal is required to address the potential damage to the gensets. Gas treatment can represent a significant cost in many small scale generation projects.

The viability of utilization as a heating fuel is largely dependant upon the proximity of the end user to the landfill site and the level of gas conditioning required to meet the demands of the heating process. Minimum LFG recovery rates required to support the capital expenditures of the LFG delivery equipment (i.e., compressor station and pipeline) are determined from the distance to the end user from the Site. As this distance increases, the relative capital cost of the utilization project increases proportionally. Depending on the space heating process (e.g., radiant heaters, boiler, forced air), treatment of the gas may not be required, but in most cases would be less onerous and less costly than treatment of gas for use in reciprocating engine gensets.

An economic assessment of utilization options would require detailed information regarding the energy demand profile of potential local users of the gas for direct use options. To evaluate the economics of utilizing the gas for power generation, an assessment of the local electrical power transmission and distribution systems would be required, such as interconnection requirements and power purchase opportunities and pricing. As of March 2006, the Ontario government has agreed to purchase green energy at a base price of 0.11 ¢ per kilowatt-hour from small operations. LFG systems are encouraged sources of green energy and are classified as small operations. Thus, if power is supplied back to the power grid from the City of Stratford Landfill LFG collection system, the City would be able to offset the cost of LFG production, while still obtaining the desired GHG reductions.

Assumptions:

- The landfill continues to be filled until 2020 with no major change of operation
- The landfill will receive 25,000 tonnes of wastes annually from 2008 to 2020
- The landfill waste continues to have a waste breakdown generic to municipal solid wastes (10% organics; 90% plastics, metals and other materials)
- There is a 75% waste diversion rate from 2008 onward
- There is a 70% recovery of landfill gas

Table 2-3 shows the areas of potential GHG reduction for the City of Stratford Landfill.

TABLE 2.3
POTENTIAL GHG REDUCTIONS

Measure	Estimated GHG Reduction Potential
Increase Waste Diversion	0.48 tonnes CO_2e per tonne waste diverted from landfill
Landfill Gas Flaring	27,000 tonnes CO_2e/year

3. Review and Profile of Energy Consumption in Facilities

Landfill Facilities

The landfill building profile is presented in Table 2-1.

TABLE 3.1
LANDFILL FACILITIES PROFILE

Location	777 Romeo Street South
Operational Profile	Weigh scale kiosk
Building History	Built in 1990
Lighting	Fluorescent tubes
Building Heating/Cooling	Wall mount unit
Methane Gas Detection System	Yes
Windows	3 windows
Doorways	1 person door
Electricity Meterage	Yes

A site visit was not conducted of the City's landfill facility. Some general recommendations to decrease electricity use are as follows:

- Develop a lighting (energy saving) strategy for the building. Install automatic sensors in certain locations to turn lights on and off or dim lights while supplemental natural light from skylights and windows increases during the day.
- Replace the old windows with new thermal windows.
- Incorporate daily meter/sub-meter readings into routine tasks as well as increasing observation of peak demands both during the day and overall season. Establishing this detailed baseline of electricity use will assist in developing a strategy to shift peak loads to times where electricity may be cheaper.

Overall Recommendations

Based on the large quantity of GHG reduction potential it is recommended that a LFG collection system be seriously considered. With the implementation of a LFG collection system the City would not only exceed their reduction targets, but would also have the opportunity to receive economic benefit from the production of green electricity. These positive aspects of a LFG collection should provide a basis for further investigation.

APPENDIX D

CITY OF STRATFORD CORPORATE ENERGY PLAN
REVIEW OF ENERGY EFFICIENCY OPPORTUNITIES
MODULE D – WATER AND WASTEWATER SYSTEMS

City of Stratford Corporate Energy Plan
Review of Energy Efficiency Opportunities

Module D:
Water and Wastewater Systems

Prepared for

City of Stratford

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1. Review and Profile of Energy Consumption in Facilities

Background

This document is intended as a sub component to Stratford's overall Community Energy Action Plan (CEP) which sets out the city's strategy to meet its commitment to the Federal Government's Partners for Climate Protection Program (PCP program). The recommended Green House Gas reduction goal as set out in the program is to achieve a 20% reduction within City operated facilities and 6% reduction in the greater community below 2003 energy use levels, by the year 2014.

The objective of this module is to provide a high level review of water and wastewater facility energy use and identify target areas where opportunities for improved energy use may exist. The facilities in this module include: The Stratford Sewage Treatment Plant; various water storage facilities, such as, towers and reservoirs (here after referred to as Reservoirs) and various water pumping stations.

Overall Energy Consumption

Figure 1-1 provides an historical trend of overall energy use in the City of Stratford's facilities listed in this module. Electricity data is presented only by operations and not disaggregated for each facility. Due to lack of electricity data, the energy use for each facility cannot be seen and analyzed. There was also incomplete data for the years 2000, 2001 and 2005; this presents a wide range of uncertainty to the trends illustrated in the Figures below.

In Figure 1-1, trend line within the graph indicates the CO_2 emissions. Taking a look at years 2002, 2003 and 2004 where there is the most complete data, the graph indicates that total overall energy use for these facilities has increased; subsequently, so has CO_2e emissions. The electricity usage by water/wastewater related facilities in 2003 was approximately 7,842,461 KWh, which translates to 2,141 tonnes of CO_2e emissions.

FIGURE 1-1
Overall CO_2 Emissions (Tonnes) Derived From Electricity Use

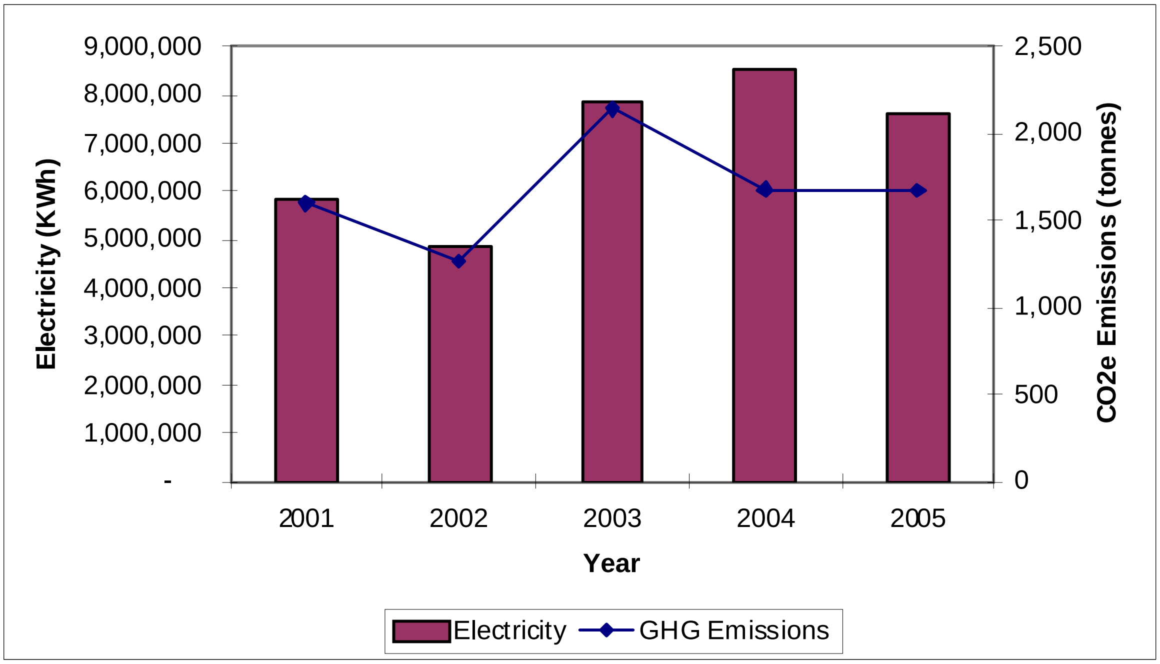


Table 1.1 presents the CO_2e emission reduction targets from 2003 levels on an operation class basis for Stratford's water operations. The difference in GHG emissions should be higher as there are three months of data missing from the 2005 data set for water supply. This missing data creates a level of uncertainty to the analysis. Electricity usage is broken down into two operation categories: Sewage and Water Supply. Sewage represents all activities occurring at the Sewage Treatment Plant. Similarly, Water Supply indicates all activities involved with distributing, holding and treating Stratford's water supple.

TABLE 1.1
CO_2e Amounts (derived from Electricity Use)

Operation Class	2003 Electricity Use (KWhs)	2003 CO_2e (tonnes)	2005 Electricity Use (KWhs)	2005 CO_2e (tonnes)	Difference in CO_2e (tonnes)
Sewage	3,036,438	829	3,342,579	735	-94
Water Supply	4,806,023	1,312	4,238,378	933	-376
Totals	**7,842,461**	**2,141**	**7,580,956**	**1,668**	**-470**

According to Table 1.1, there has been an approximate reduction of 470 tonnes of CO_2e is in year 2005 from 2003 levels. Please take note, the 2005 dataset was incomplete and the difference in electricity emissions coefficients.

TABLE 1.2
CO_2e Reduction Targets (derived from Electricity Use)

Operation Class	2003 Emissions (CO_2e tonnes)	Reduction Target - 20% from 2003 values (CO_2e tonnes)	2005 Emissions (CO_2e tonnes)	Difference between Target and 2005 values (CO_2e tonnes)
Sewage	829	663	735	72
Water Supply	1,312	1,050	932	-117
Totals	**2,141**	**1,713**	**1,668**	**-45**

Table 1.2 summarizes the emissions target. A reduction of 20% from 2003 values is 1,713 CO_2e tonnes; the amount of emissions in 2005 is lower than the reduction target by 45 CO_2e tonnes.

Energy Use Trends and Benchmarking Performance

Table 1.3 lists the buildings represented in this module; all facilities were toured during this audit.

WATER & WASTEWATER SYSTEM FACILITY NAME, ADDRESS, AND FUNCTION CATEGORY

TABLE 1.3
Water & Wastewater System Facility Name, Address, and Function Category

Facility Name	Address	Function
Stratford Sewage Treatment Plant	701 Gore St. W.	Sewage Treatment Plant
Dufferin Street Water Tower	221 Dufferin St.	Reservoir
Forman Avenue Water Tower	430 Forman Ave.	Reservoir
Chestnut Street Well	NA	Reservoir
Mornington Street Well	637 Mornington St.	Reservoir
Dunn Well Road Well	100 Dunn Road	Reservoir
Lorne Avenue Well	500 Lorne Ave. W.	Reservoir
Cooper Street Well	161 Wellington St.	Reservoir
O’Loane Avenue Well	947 O’Loane Ave.	Reservoir
Water Supply Control Station	39 Romeo St.	Reservoir
Vivian Pump Station	360 Romeo St. S.	Sanitary Pumping Station
Devon Street Pump Station	Devon at Meighton Mews	Sanitary Pumping Station
Douro Pump Station	752 Douro St.	Sanitary Pumping Station
Romeo Street Stormwater Pump Station	97 Romeo St. S.	Stormwater Pumping Station
Burritt Street Pump Station	3 Burritt St.	Sanitary Pumping Station
Dunn Street Pump Station	240 Dunn Rd.	Sanitary Pumping Station
Taylor Pump Station	NA	Sanitary Pumping Station

TABLE 1.3
Water & Wastewater System Facility Name, Address, and Function Category

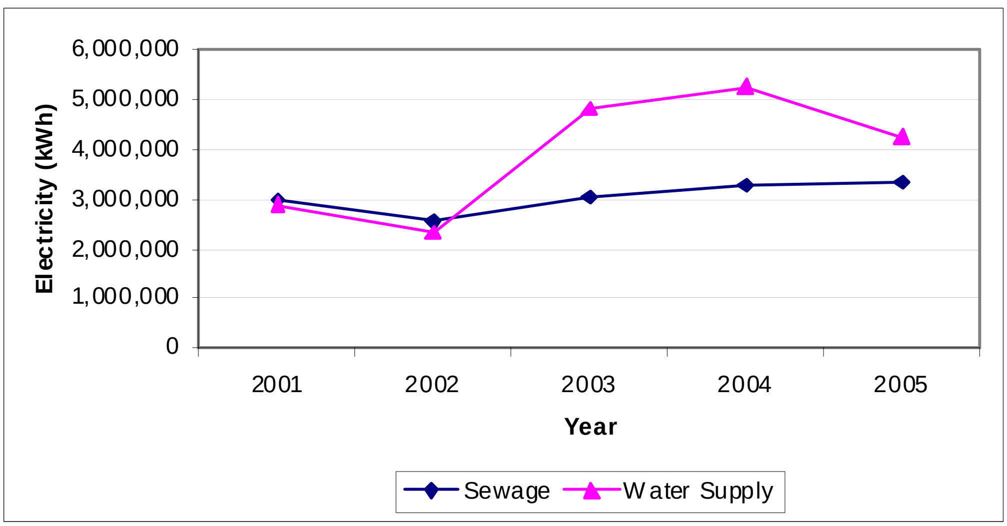
Facility Name	Address	Function
Vic Inn Pump Station	NA	Sanitary Pumping Station
Lorne Avenue Station	NA	Sanitary Pumping Station
Downie Station	NA	Sanitary Pumping Station

All Pump Stations, with the exception of the pump station located on Romeo Street, are sanitary pumping stations; The Romeo Street station is a stormwater pumping station.

Historical Energy Use Patterns

A review of available historical energy use patterns can provide insight into the changes in operational patterns or significant load additions at each facility. Figures 1-2 and 1-3 provides an historical perspective of electricity use by operations from 2000 to 2005.

FIGURE 1-2
Electricity Use by Operations: 2000 - 2005



Note:
[1] Incomplete information available for Water Supply and Sewage Operations in 2000 and 2001

Upon review of the sewage treatment plant's electricity usage, the overall usage appears to be increasing. In regards to Water Supply facilities, a trend cannot be seen with the available data; there was an increase in 2004 values from 2003, but a significant decrease in 2005. While electric heaters and lighting are present at most facilities, the main electrical demand appears to be a function of population shifts. Seasonal increases in population may be increasing the demand on water and wastewater facilities. Economics and weather are also factors of electricity usage.

General Recommendations

Water and Wastewater treatment produces high energy demands as a result of aeration and pumping requirements. There are some minor recommendations with respect to energy conservation at the treatment and pumping buildings, but the majority of the energy demand is from high service pumps that convey water for treatment. The primary route to energy reduction is through water use reduction within the community thereby reducing the volume of water requiring treatment and accordingly, less energy will be used. Significant reductions in water use have been implemented by various municipalities by implementing water use programs and by-laws for outside water use; low-flush toilet rebate programs; industrial capacity buy back programs; sewer discharge metering and associated sewer surcharges to water bills; and Community general awareness campaigns.

With respect to water supply, water loss through the distribution system creates additional pumping demands and energy use. Undertaking a distribution system water balance audit would identify volumetric losses and potential sources of leakage.

Information related to each of the facilities toured during the energy audit is included in the following section.

2. Potential Opportunities for Improved Energy Efficiency

Sewage Treatment Plant

The Sewage Treatment Plant profile is listed in Table 2.1.

TABLE 2.1
Sewage Treatment Plant Profile

Location	701 Gore St. W.
Operational Profile	Continual Operation
Building History	The original facility was built in the 1950s and has under gone two major upgrades in 1994 and 2003. The majority of the facilities are independent aboveground structures with basements with no service tunnels between them. The facility includes an influent pump station, CSO facility, combined headworks/workshop/administration facility, chemical storage/blower/stand-by power/RAS Pumping facility, tertiary/UV disinfection facility, digester complex, and a separate staff/lunchroom/garage/archive facility.
Building Energy Management System	Notwithstanding the digester complex and tertiary/UV disinfection facility, the plant does not have an integrated building energy management system. Digester gas is utilized by a boiler located in the digester complex for process heating and supplies heat to the digester complex and tertiary treatment facility. The combined headworks/workshop/administration facility has a propane fired hot water boiler system for building heat. Originally this facility was also heated by the boiler in the digester complex. However, due to a break in the Hot Water Supply/Return lines the system was replaced with the propane powered hot water system. AC units are used to provide cooling in the administration area of the building. The chemical storage/blower/stand-by power/RAS Pumping facility has electric heating for the building. However for the RAS pumping gallery located in the basement of the building, residual heat from the blowers room located above is recovered to provide heating in the basement. The various areas in the building are provided with electrically actuated louvers for heat relief during the summer. The staff/lunchroom/garage/archive facility has a combined electric heating and cooling system. All other buildings on the site are not continuously occupied and are provided with electric heating to prevent freezing and electrically actuated louvers for heat relief during the summer.
Lighting	
Main Administration Office (offices, meeting room, laboratory, control room and equipment bay and storage)	The plant is currently replacing the lighting in the administration facility to fluorescent fixtures (T-8 and T-12).
Lunch, Staff, Garage and	The facility uses fluorescent lighting.

TABLE 2.1
Sewage Treatment Plant Profile

Archive Building	
Influent Pumping	The main room has a combination of fluorescent fixtures and combined compact fluorescents and High Pressure Sodium (HPS) fixtures. The MCC/Electrical room has fluorescent lights.
CSO Facility	The combined sewer overflow (CSO) facility has fluorescent lights in the chemical dosing area and in the MCC Electrical room and lab area.
Preliminary Treatment Room	The preliminary treatment room uses compact fluorescent fixtures enclosed in explosion proof housings.
Chemical storage/ Blower /stand-by power /RAS Pumping Building	This building uses a combination of fluorescent and HPS fixtures.
Tertiary Treatment Building	This building uses a combination of fluorescent and HPS fixtures.
Digester Complex	All areas in the digester complex use fluorescent fixtures in explosion proof housings except for the gas room that uses incandescent fixtures in explosion proof housings.
Exterior Lights	All exterior lights are HPS fixtures with photocells.
Interior Lights (general)	All interior lights are controlled by switches with no motion control.
Building Heating/Cooling/Ventilation	
Main Administration Office	Propane powered hot water boiler system with hot water space and baseboard heaters. The admin area also has air conditioning units for the summer.
Lunch, Staff, Garage and Archive Building	Electric heating and air conditioning.
Influent Pumping	Electric heating for protection against freezing. There are temperature controlled louvers for heat relief during the summer inside the building. The screw pumps/wet well is enclosed with ventilation.
CSO Facility	Electric heating for protection against freezing. There are temperature controlled louvers for heat relief during the summer inside the building.
Preliminary Treatment Room	Hot water heating in the process area with ventilation for odour control. There are temperature controlled louvers for heat relief during the summer inside the building.
Chemical storage/ Blower /stand-by power /RAS Pumping Building	Electric heating for the chemical storage area and MCC room. The stand-by power room is not heated and the diesel engine has a block heater. There are mechanical actuated louvers for heat relief and combustion air supply. The blower room has mechanically actuated louvers for heat relief. The RAS pumping gallery is heated with recovery heat from the blower room.
Tertiary Treatment/UV Disinfection Building	Heating provided by the digester hot water heating system. There are actuated louvers for heat relief and ceiling fans in the UV disinfection room.
Digester Complex	Heating is provided by the hot water system and through residual heat from the digesters themselves.
Cooling	The administration areas and lunch room/staff building have air conditioning units.
Other equipment	

TABLE 2.1
Sewage Treatment Plant Profile

Generators/Transformers	There is one stand-by diesel generator to operate during power outages. There are several transformers of various sizes throughout the facility.
Heat Exchangers /Boilers	In the digester building, there is one heat exchanger for process heating. The hot water system is used to heat the digester complex and tertiary treatment/UV disinfection building.
Exhaust Fans	Exhaust fans are present in almost every building and are controlled by gas detectors, thermostats or manual switches.
Pumps	There is a multitude of pumps that exist in the treatment facility. All pumps are electric and vary in both size and function, for example, the pumping of digester sludge, hot water heating system or simply moving sewage or water through the various stages of treatment. It is noted that the facility uses two intermediate pump stations, a primary effluent pump station and a tertiary treatment pump station. Typically plants are designed to flow by gravity from the influent pump station to the outfall. However due to hydraulic grade line constraints and flooding concerns the plant is designed to operate with the intermediate pump stations.
Hot Water Heater	There is one gas hot water heater and three electric hot water heaters – one for the administration office, CSO building, chemical storage area. The staff lunch room and change room has a Natural Gas hot water heater.
Building Envelope	
Exterior	Not withstanding the administration/workshop/and preliminary works building that has a siding exterior, all buildings have a read brick veneer.
Windows	For the most part, windows are sealed double paned glass in the buildings that can be opened. In addition to windows several of the buildings have glass block windows to allow natural heat. The workshop building has single pane windows that the plant is planning on replacing.
Doorways	All buildings have hollow metal entry doors.
Meterage	
Gas	There is one meter for the entire facility and one propane tank for the administration/workshop/and preliminary works building.
Electricity	There is one meter for the entire facility.

The original facility was built in the 1950s and has since undergone two major additions to accommodate population growth in Stratford. The majority of the facilities are aboveground. The facility consists of an influent pump station, CSO facility, combined headworks/workshop/administration facility, chemical storage/blower/stand-by power/RAS Pumping facility, tertiary/UV disinfection facility, digester complex, and a separate staff/lunchroom/garage/archive facility. Most of the building windows are sealed double paned glass which can be opened. All the building doorways have are metal entry doors.

The administration building has offices, meeting rooms, a laboratory, a control room, and an equipment bay and storage. The administration office is currently converting all lighting to fluorescent fixtures. There is a separate facility for staff, lunch, garage and archives; this facility uses fluorescent lighting.

Heating and cooling methods vary around the facility. There is a propane powered hot water boiler system with hot water space and baseboard heaters that heats the administration area; there are air conditioning units to cool the administration area during the summer. There is electric heating in the lunch/staff/garage and archive building as well as the CSO Facility, preliminary treatment room and the chemical storage area of the RAS pumping building. The digester hot water heating system and residual heat from the system provides heat to the Tertiary Treatment/UV Disinfection Building and the Digester Complex. There are actuated louvers for heat relief and ceiling fans in the UV disinfection room.

Little automatic controls have been implemented at the facility. The facility uses a combination of standard incandescent, fluorescent or HPS fixtures controlled by a light switch. Incandescent lighting is used in the administration buildings and the plant is currently replacing the lighting in the administration facility to fluorescent fixtures (T-8 and T-12). There have been reports that several sensors and lights have been malfunctioning. Employees typically turn out lights at the end of the day in their respective work areas. All interior lights are controlled by switches with no motion control.

Recommendations

It is recommended that the sewage treatment plant implement the following energy reduction initiatives:

- Install motion detector switches on all interior lights.
- Change gas room incandescent lights to compact fluorescents.
- It was also noted that the facility currently uses potable water for the tipping buckets at the combined CSO facility. This could be changed to use plant effluent water. This would decrease the overall energy consumption of the facility as the need for potable water is reduced.
- Convert the propane powered boiler heating system to natural gas or reinstate the hot water supply from the digester complex.

To significantly lower energy consumption, and subsequently GHG emissions, it is highly recommended that the sewage treatment plant install a system which will allow plant effluent water to be used for tipping buckets at the CSO facility. This is a relatively simple solution to conserve energy. Converting the heating system or reinstating the hot water supply from the digester complex is the solution that would impact the energy consumption the greatest; however, it is more complicated than re-routing plant effluent water to the CSO facility and would require further investigation.

Pump Stations

There are 9 sanitary and 1 stormwater pump stations in Stratford with facilities -Vivian Pump Station, Duoro Pump Station, Dunn St. Pump Station, Devon St. Pump Station, Burritt St. Pump Station, Taylor Pump Station, Vic Inn Station, Lorne Avenue Station and Downie Station, and Romeo St. Pump Station, respectively. A pump station's main operational function is to receive sanitary and storm wastewater from the wastewater collection system. Equipment housed in the buildings generally includes 2 to 3 submersible pumps, panel, switches, valves, electric heaters and diesel generators.

Table 2.2 includes Pump Station profiles of the pump stations visited, along with energy reduction recommendations. Site visits were not conducted for the following stations: Taylor Station, Vic Inn Station, Lorne Avenue Station and Downie Station

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

VIVIAN PUMP STATION	
Location: 360 Romeo St S	
Operational Profile	Continual operation
Building History	Built in 1999. Brick veneer building with a peaked roof.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Control panels operate pumps and with alarm dial-out. Inside lights are controlled manually.
Lighting	
Interior Lights	Fluorescent lighting
Exterior lights	HPS on switch
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat with T-stat control
Cooling	Automatic louvers with T-stat control for heat relief
Ventilation	Forced air ventilation for dry-pit area that runs continuously Forced air ventilation for wet well area that runs intermittently (tied to gas monitoring system and switched)
Other Equipment	
Sewage Pumps	Two 7.4 Submersible Pumps in a dry-pit configuration
MCC Control Panel	Electrical, control equipment, autodialer
Stand-by Power	Portable 50 kW diesel generator
Building Envelope	
Windows	No windows
Doors	Double door at the main entrance, Garage Door for portable genset

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

Meterage	
Electricity	One main meter for the building
Recommendations	Recommend putting dry-pit ventilation on switch to operate when well is occupied with gas monitoring to turn on system when there is a gas alarm. Installing a switch in addition to photocell on Exterior light as station is not manned. Installing a motion detector switch on interior lights. Lowering temperature in building to prevent freezing when un-manned. Temperature should be set above minimum for diesel generator operation or install a block heater on the generator.
DEVON ST PUMP STATION	
Location: Devon at Meighton Mews	
Operational Profile	Continual operation
Building History	Built in 1975. Brown brick veneer building with a flat roof.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Control panels operate pumps and with alarm dial out. Inside lights are controlled manually.
Lighting	
Main pump room	Fluorescents
Exterior lights	HPS on photocell
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heating
Cooling	Automatic louvers for heat relief
Ventilation	N/A
Other Equipment	
Sewage Pumps	Two 7.4 kw Submersible Pumps
MCC Control Panel	Communication and control equipment
Stand-by Power	Permanent 26 kW diesel generator
Building Envelope	
Windows	No windows
Doors	Single door at the main entrance
Meterage	
Electricity	One main meter for the building
Recommendations	Installing a switch in addition to photocell on Exterior light as station is not

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

	manned. Installing a motion detector switch on interior lights. Lowering temperature in building to prevent freezing when un-manned. Temperature should be set above minimum for diesel generator operation or install a block heater on the generator.
DOURO PUMP STATION	
Location: 752 Douro St.	
Operational Profile	Continual operation
Building History	Built in 1966. Red brick veneer building with a peaked roof.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Control panels operate pumps and alarm dial out. Inside lights are controlled manually.
Lighting	
Main pump room	Fluorescents
Exterior lights	N/A
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heating
Cooling	Automatic louvers for heat relief
Ventilation	Forced air ventilation in dry-pit
Other Equipment	
Sewage Pumps	Two 14.8 kW dry well Pumps
MCC Control Panel	Communication and control equipment
Stand-by Power	Permanent 50 kW diesel generator
Building Envelope	
Windows	Single pane windows
Doors	Single door
Meterage	
Electricity	One main meter for the building
Recommendations	Installing a switch in addition to photocell on Exterior light as station is not manned. Installing a motion detector switch on interior lights. Lowering temperature in building to prevent freezing when un-manned. Temperature should be set above minimum for diesel generator operation or install a block heater on the generator.

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

ROMEO ST PUMP STATION	
Location: 97 Romeo St. N.	
Operational Profile	Intermittent operation for stormwater flows
Building History	Built in 1969. Grey steel veneer building with a flat roof.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Control panels operate pumps and alarm dial out. Inside lights are controlled manually.
Lighting	
Main pump room	Fluorescents
Exterior lights	HPS
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric
Cooling	Automatic louvers for heat relief
Ventilation	N/A
Other Equipment	
Sewage Pumps	Three 29 HP submersible Pumps
MCC Control Panel	Communication and control equipment
Stand-by Power	Permanent 60 kW diesel generator
Building Envelope	
Windows	No windows
Doors	Single door at the main entrance
Meterage	
Electricity	One main meter for the building
Recommendations	Installing a switch in addition to photocell on Exterior light as station is not manned. Installing a motion detector switch on interior lights. Lowering temperature in building to prevent freezing when un-manned. Temperature should be set above minimum for diesel generator operation or install a block heater on the generator.
BURRITT ST PUMP STATION	
Location: 3 Burritt St.	
Operational Profile	Continuously
Building History	Built in 1977. Brown steel veneer building with a peaked roof.
Building Energy	Heating provided by one electric heater with manual controls, building

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

Management System	maintained to prevent freezing conditions in building. Control panel operate pumps and alarm dial out. Inside lights are controlled manually.
Lighting	
Main pump room	One incandescent light
Exterior lights	HPS on switch
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric
Cooling	N/A
Ventilation	N/A
Other Equipment	
Sewage Pumps	One 1.5 HP and 3 HP submersible Pumps
MCC Control Panel	Communication and control equipment
Stand-by Power	N/A
Building Envelope	
Windows	No windows
Doors	Single door
Meterage	
Electricity	One main meter for the building
Recommendations	Replacing incandescent with fluorescent light.
DUNN ST PUMP STATION	
Location: 240 Dunn Rd.	
Operational Profile	Continuously
Building History	Built in 1998. Brick veneer building with a peaked roof.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained to prevent freezing conditions in building. Control panel operate pumps and alarm dial out. Inside lights are controlled manually.
Lighting	
Main pump room	Florescent lights
Exterior lights	HPS on photocell
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric
Cooling	Louvers for heat relief

TABLE 2.2
Sanitary and Stormwater Pump Station Profiles and Energy Reduction Recommendations

Ventilation	N/A
Other Equipment	
Sewage Pumps	Two submersible Pumps
MCC Control Panel	Communication and control equipment
Stand-by Power	40 kW stand-by generator
Building Envelope	
Windows	No windows
Doors	Single door and garage door
Meterage	
Electricity	One main meter for the building
Recommendations	Installing a switch in addition to photocell on Exterior light as station is not manned. Installing a motion detector switch on interior lights. Lowering temperature in building to prevent freezing when un-manned. Temperature should be set above minimum for diesel generator operation or install a block heater on the generator.

Heating throughout these facilities are provided by one electric heater with manual controls. None of the buildings have windows with the exception of the Douro Pump Station which has single pane windows. The amount of insulation in the buildings is unknown. An automatic vent with louvers is present in each building for heat relief.

Lighting consists of fluorescents lights in the main pump rooms and HPS fixtures as exterior lighting. The Burritt St. Pump Station uses one incandescent light in the main pump room. All lighting is controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required. Internal lights are only turned on when employees are present.

All lights are currently switched on manually. It is recommended that each facility install motion detector for the interior lights and additional photocell to the exterior lights. Lowering temperature in building to prevent freezing when un-manned would reduce electricity use. However, it should be noted that temperatures should be set above minimum for diesel generator operation.

Overall Recommendations

Implementation of the above recommendations for the sewage treatment plant and the pump stations would help Stratford decrease GHG emissions and meet the reduction targets as well as provide an opportunity to receive economic benefit from electricity use decrease. The recommendations should provide a basis for further investigation.

Water Wells and Towers

The profiles for water towers and wells are listed in Table 2.3, along with energy reduction recommendations.

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

DUFFERIN STREET WATER TOWER	
Location: 221 Dufferin Street	
Operational Profile	Continual operation
Building History	Built in 1964. The control room is a brick structure located inside the base of the painted steel tower.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature. Lights are controlled manually.
Lighting	
Main Room	Compact fluorescents.
Exterior lights	Multivapour and HPS lighting on Timer Control.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric baseboard heating.
Cooling	N/A
Ventilation	N/A
Other Equipment	
Pumps	N/A
MCC Control Panel	N/A
Stand-by Power	N/A
Building Envelope	
Windows	N/A
Doors	Single steel door into base of structure, with another steel door for the control room.
Meterage	
Electricity	One main meter for the building
Recommendations	Install a photocell for the exterior lights. Install motion sensors on interior lights.
FORMAN AVENUE WATER TOWER	
Location: 430 Forman Avenue	

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Operational Profile	Continual operation
Building History	Built in the 90's, as steel water tank sits on top of a reinforced concrete structure. The control room is located inside the tower based and is a concrete masonry structure.
Building Energy Management System	Heating provided by one electric heater with manual controls, building maintained near room temperature.
Lighting	
Main Room	Fluorescent lights on a switch
Exterior lights	HPS lights on timer control.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat
Cooling	N/A
Ventilation	N/A
Other Equipment	
Pumps	N/A
MCC Control Panel	N/A
Stand-by Power	N/A
Building Envelope	
Windows	N/A
Doors	Double door to exterior and single door to control room.
Meterage	
Electricity	One main meter for the building
Recommendations	Install a photocell on exterior lights. Install motion sensors on interior lights.
CHESTNUT STREET WELL	
Location:	
Operational Profile	Continual operation
Building History	Building in the 1950's the building is a brick veneer structure that houses the control, chlorine room, and reservoir.
Building Energy Management System	Electric heat

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Lighting	
Interior Lights	Fluorescents, switched.
Exterior lights	HPS lights on a timer.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric Heat.
Cooling	Passive louvers for heat relief and ventilation.
Ventilation	Forced air ventilation in chlorine room that is manually controlled.
Other Equipment	
Pumps	One well pump and high lift pump.
MCC Control Panel	N/A bus bar/splitter.
Stand-by Power	N/A
Building Envelope	
Windows	None
Doors	Single man door to exterior.
Meterage	
Electricity	One main meter for the building
Recommendations	Install a photocell on exterior lights. Install motion sensors on interior lights. It was noted that the electrical equipment has experienced corrosion due to chlorine gas and moisture exposure, it is recommended that the electrical equipment be enclosed in a separate vestibule.
MORNINGTON STREET WELL	
Location: 637 Mornington Street	
Operational Profile	Continuous operation
Building History	Built in the 60's the building is a brick veneer structure with a sloped concrete roof.
Building Energy Management System	Electric heat.
Lighting	
Interior Lights	Fluorescent and incandescent lights.
Exterior lights	N/A
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Cooling	Passive louvers for heat relief and ventilation.
Ventilation	Forced air ventilation for chlorine room that is manually controlled.
Other Equipment	
Pumps	One well pump and high lift pump.
MCC Control Panel	Recently replaced.
Stand-by Power	Portable genset connection.
Building Envelope	
Windows	N/A
Doors	Steel door.
Meterage	
Electricity	One main meter for the building
Recommendations	Install motion sensors on interior lights.
DUNN ROAD WELL	
Location: 100 Dunn Road	
Operational Profile	Continuous operation
Building History	Built in the 1980's the building has a brick veneer with a slopped steel roof.
Building Energy Management System	The building has electric heat.
Lighting	
Interior Lights	Fluorescents.
Exterior lights	HPS lights on timer control.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat
Cooling	Passive louvers for heat relief and ventilation.
Ventilation	Force air ventilation for chlorine room that is manually controlled.
Other Equipment	
Pumps	One well pump
MCC Control Panel	Electrical, control equipment
Stand-by Power	Connection for portable power
Building Envelope	
Windows	N/A

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Doors	Double Door
Meterage	
Electricity	One main meter for the building
Recommendations	Install a photocell on exterior lights. Install motion sensors on interior lights
LORNE AVENUE WELL	
Location: 500 Lorne Avenue West	
Operational Profile	Continuous operation
Building History	Built in the 1980's the structure is shared with a hydro substation. The building has a brick veneer with a sloped asphalt room and a flat roof.
Building Energy Management System	Electric heat
Lighting	
Interior Lights	Fluorescent lighting.
Exterior lights	HPS lighting on timer control
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat.
Cooling	Passive louvers for heat relief and ventilation.
Ventilation	Forced air ventilation for chlorine room that is manually controlled.
Other Equipment	
Pumps	One well pump
MCC Control Panel	Electrical, control equipment
Stand-by Power	N/A
Building Envelope	
Windows	N/A
Doors	Double doors
Meterage	
Electricity	One main meter for the building
Recommendations	Install a photocell on exterior lights. Install motion sensors on interior lights
COOPER STREET WELL	
Location: 161 Wellington Street (rear)	
Operational Profile	Off-line since 2000 used for monitoring purposes only.

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Building History	Built in the 1920/1930's. Building is combination of block and corrugated steel siding.
Building Energy Management System	Electric heat.
Lighting	
Main pump room	Fluorescent
Exterior lights	N/A
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat.
Cooling	Passive louvers for heat relief and ventilation.
Ventilation	N/A
Other Equipment	
Pumps	N/A
MCC Control Panel	N/A
Stand-by Power	N/A
Building Envelope	
Windows	None.
Doors	One door.
Meterage	
Electricity	One main meter for the building
Recommendations	Off-line no recommendations.
O'LOANE AVENUE WELL	
Location: 947 O'Loane Avenue	
Operational Profile	Continuous operation.
Building History	Built in the 90's the structure is a brick veneer with a steel roof.
Building Energy Management System	Electric heat.
Lighting	
Interior Lights.	Fluorescent lights on switches.
Exterior lights	HPS on photocell.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat.
Cooling	Passive louvers for heat relief and ventilation.

TABLE 2.3
Water Towers/Wells Profiles and Energy Reduction Recommendations

Ventilation	Forced air ventilation for chlorine room that is manually controlled.
Other Equipment	
Pumps	One pump.
MCC Control Panel	Electrical, control equipment
Stand-by Power	Portable generator connection.
Building Envelope	
Windows	N/A
Doors	Two doors.
Meterage	
Electricity	One main meter for the building
Recommendation	Install motion sensors on interior lights

There are two water towers and six wells in Stratford. The Copper Street Well located at 161 Wellington Street is the only well off-line; all other facilities are in continuous operation. The main operational function of these facilities is to hold water for the local distribution area. The well facility may house a control and chlorine room and a reservoir. The equipment housed in the water towers generally only includes electric heaters; equipment in the well facilities includes electric heaters and one or two pumps.

Heating throughout the facility is provided by one electric heater with manual controls. Neither the water towers nor wells have windows.

Lighting consists of fluorescents fixtures controlled manually with a switch. The building is only occupied for short periods of time for routine checks unless maintenance is required.

Overall Recommendations

Due to the simplicity of the facilities and the operations associated with water towers and wells, the main recommendations to conserve energy at these locations are to install photocell on exterior lights and motion sensors on interior lights.

Water Supply Control Station

The profile the Water Supply Control Station is listed in Table 2.4, along with energy reduction recommendations.

TABLE 2.4
Water Supply Control Station Profile and Energy Reduction Recommendations

LOCATION: 39 ROMEO STREET	
Operational Profile	Continuous operation. This location also serves as the main control centre for the water supply system, houses the silica addition system for the water supply system and also house the meter calibration and repair shop for the City.
Building History	Built in the 60's. A brick veneer building with a flat roof
Building Energy Management System	Electric heat.
Lighting	
Interior Lights.	Fluorescent lights on switches for most rooms except for pump room that has incandescent lights.
Exterior lights	HPS on timer.
Building Heating/Cooling/Air Flow and Ventilation	
Heating	Electric heat maintained at room temperature as building is occupied during normal business hours.
Cooling	Passive louvers for heat relief and ventilation. Stand-by power room has automatic louvers for heat relief and combustion air.
Ventilation	Forced air ventilation for chlorine room that is manually controlled. Exhaust hood/ducting in metering shop for meter painting.
Other Equipment	
Pumps	Three pumps.
MCC Control Panel	Electrical, control equipment
Stand-by Power	One permanent installed diesel genset.
Building Envelope	
Windows	Double paned windows with windows that open.
Doors	Several steel doors into the building
Meterage	
Electricity	One main meter for the building
Recommendation	Install motion sensors on interior lights Install photocell for exterior lights.

The Water Supply Control Station serves as the main control location for the City's water supply. Water is treated at this location and then distributed to the water supply system. The equipment housed in the facility includes electric heaters and the electric control equipment, diesel genset for stand-by power, and three pumps.

Lighting consists of fluorescents fixtures controlled manually with a switch. The pump room still uses incandescent lights. Exterior lights are high pressure sodium (HPS) fixtures and controlled by a timer.

Overall Recommendations

Due to the simplicity the operations at this facility, the main recommendations to conserve energy at these locations are to install photocell on exterior lights and motion sensors on interior lights.