# Community Energy Plan Action Area 2: Transportation

*Revision 4 Report - Final*

*July 18, 2006*

Community Energy Plan Action Area 2: Transportation

City of Yellowknife & the Arctic Energy Alliance

06-5992-1000

Gary Strong - Project Manager

*Submitted by*

**Dillon Consulting Limited**

*(In reply, please refer to)*
*Our File: 06-5992-1000*

DILLON CONSULTING

4920
47th Street
Suite 303
Box 1409
Yellowknife
Northwest Territories
Canada
X1A 2P1
Telephone
(867) 920-4555
Fax
(867) 873-3328

July 18nd, 2006

City of Yellowknife
P.O. Box 580
Yellowknife, NT
X1A 2N4

Attention: Greg Kehoe
Director of Public Works

**Re: CEP Action Area 2: Transportation**

Dear Mr. Kehoe,

Please find enclosed two (2) hard copies and one electronic copy (in both MS Word and PDF format) of the final report entitled "Community Energy Plan Action Area 2: Transportation" Revision 4 - Final. This report responds to the concerns raised by AEA in our meeting of July 11, 2006.

We trust that you find this report acceptable. Should you have any questions or concerns regarding this submission, please contact me at your convenience, at (867) 920-4555, ext. 22.

Yours truly,

Dillon Consulting Limited

Gary Strong, P. Eng.
Project Manager

Cc: Andrew Robinson
Arctic Energy Alliance

**Dillon Consulting Limited**

**EXECUTIVE SUMMARY**

Forecasts suggest that energy consumption will increase in the City of Yellowknife (City) by 19% over the next 10 years. The increase in energy consumption will directly result in an increase in greenhouse gas (GHG) production.

The Community Energy Planning Committee, in cooperation with the Arctic Energy Alliance, initiated eight (8) Action Areas. Dillon Consulting Limited (Dillon) was retained to complete one of these Actions Areas – Action Area 2 – Transportation.

The Purpose of the CEP 2, Transportation Action Area is to identify actions that the City can undertake to reduce greenhouse gas produced from the transportation sector. There are two aspects of the Action Area. The first deals with transit. The second area addresses other aspects of the transportation methods used by the public, such as cars, trucks, walking, snowmobiles, etc.

The recommendations from this study are;

1. The City to consider additional incentives through permit discount for Hybrid Taxis.

2. The City to initiate a pilot program with the use of a hybrid, possibly in conjunction with the GNWT.

3. The City to further investigate the use of Biodiesel for there vehicle fleet and transit system.

4. The City should consider adding minibuses to the transit fleet

5. The City to Promote Active Transport

## TABLE OF CONTENTS



## LIST OF APPENDICES

# 1 INTRODUCTION

## 1.1 Background

Forecasts suggest that energy consumption will increase in the City of Yellowknife (City) by 19% over the next 10 years. The increase in energy consumption will directly result in an increase in Greenhouse Gas (GHG) production.

A Community Energy Planning Committee (CEPC) was created by the City to develop a Community Energy Plan (CEP). The CEP identifies Action Areas for the City to spearhead. These Action Areas are directly related to the reduction of energy demands and the reduction of GHG production. The Actions Areas also set out to inform the public of the issues associated with GHG emissions and to promote energy-saving activities.

The Action Areas identified a series of potential initiatives that could be undertaken by the City to reduce GHG production in Yellowknife. The Community Energy Planning Committee, in cooperation with the Arctic Energy Alliance, initiated eight (8) studies to assess the initiatives set out under each Action Area. Dillon Consulting Limited (Dillon) was retained to complete one of these Actions Areas – Action Area 2: Transportation.

## 1.2 Purpose

The purpose of CEP Action Area 2, Transportation is to identify actions that the City can undertake to reduce energy demand and greenhouse gas produced from the transportation sector. There are two aspects of the Action Area. The first deals with transit. The second area addresses other aspects of the transportation methods used by the public, such as cars, trucks, walking, snowmobiles, etc.

The City wishes to identify barriers associated with mass transit ridership in Yellowknife, identify means to increase ridership of the transit system, and identify ways to increase the efficiency of the transit system. The basic assumption is that a more efficient transit system with a higher ridership will result in a decrease in overall GHG production.

Initiatives to reduce GHG production in the energy sector were developed by the Community Energy Planning Committee during the energy roundtable. The results of this roundtable were reported in *Report on Energy Expert "Roundtable" Held on July 12, 2005: Revised with Input from Yellowknife CEP Committee*. The initiatives identified included:

- Promotions of Active transportation methods
- Carpooling
- No idling policies
- Use of smaller transit vehicles
- Use of alternative fuel types
- Use of hybrid vehicles

- Increasing the cost of parking meters

The project's goal is to assess how each of these initiatives could be influenced by the City and to determine the expected GHG reduction through the successful implantation of the initiatives.

# 2 METHODOLOGY

## 2.1 General

Existing data sources were used where possible. Where no data for exists for Yellowknife, then national averages and standards were used. In specific cases surveys were conducted. Due to the project timeline, 6 weeks, the surveys conducted are not scientifically, nor statistically, valid, but do provide for a reasoned approach to developing assumptions in a broad context. This approach was deemed acceptable by the client group.

## 2.2 Background Data

Much of the background data originated from the previous studies on GHG production in Yellowknife. The primary document is the work completed by Terriplan/Pembina Institute baseline study, namely; *Terriplan and Pembina Institute for Appropriate Development, City of Yellowknife Energy and Emissions Baseline. City of Yellowknife*. In this report, Terriplan and Pembina estimated GHG emissions from a variety of sectors in Yellowknife. For the transportation sector, gross fuel receipts from suppliers in Yellowknife were tabulated. GHG emissions were calculated for transportation based on fuel consumed and Natural Resources Canada's (NRCan) formulas.

Background information for specific types of vehicle use was developed by contacting sources directly such as taxi companies, The Department of Transportation and trucking companies.

Fuel consumption was determined using NRCan's estimates (see **Appendix D**) for a variety of common manufacturers such as Ford, Toyota, General Motors of Canada, Dodge, Honda, and Volkswagen for 2005. Diesel truck consumption used the assumptions from the Terriplan/Pembina study. Dealers and Cardinal Bus Lines' mechanics were contacted directly for snowmobile and City bus fuel consumption rates.

## 2.3 Surveys

### *2.3.1 Pedestrians*

Pedestrian surveys were conducted at the north and south entranceways into the downtown area (see **Appendix B**) – the corner of Franklin Ave. and 42nd Street (north) and in front of the Aurora College on Franklin Avenue near the corner of 54th Street (south). The pedestrian surveys were performed at the peak morning commuting time between 8 and 9 a.m. at on March 21st and 22nd, 2006. A visual observation of the morning commuters along and on the Frame Lake Trail (Trail) was conducted simultaneously to capture the number of commuters during the same survey period. Dillon personnel counted pedestrians, cyclists and snowmobilers who passed the surveyor along the Trail. Results were tallied for a final comparison against all other modes of transportation to and from work and to develop an understanding of the proportion of individuals who use "Active Transport"[1].

[1] Active transport is the use of non-motorized methods of transportation

### *2.3.2 Carpooling*

Commuters who partook in carpools were visually observed at the same time as the pedestrian surveys. [A carpool, for the purpose of this study, is defined as vehicles with more than one person.] The number of commuters who carpooled was compared to historical traffic counts at or near the location of the visual surveys (corner of Franklin Ave. and 54th St. in 1994 and Franklin and 44th St. in 2003) to determine an estimated proportion of commuters who carpooled.

### *2.3.3 Email Survey*

An email survey was sent out to individuals working in downtown office spaces. Individuals were chosen randomly from online phone directories. The email inquired about their usual commuting habits. The survey consisted of four questions:

1. Where in Yellowknife do you live (Oldtown, Downtown, Range Lake etc…)?

2. What method of transportation do you most commonly use to get to work (walking, biking, driving, public transport etc)?

3. Do you carpool to work? How often?

4. Does your method of transportation change depending on the season? How?

The purpose of the email survey was to gain an understanding of commuter habits in Yellowknife.

### *2.3.4 Downtown Parking*

A visual survey of downtown parking was done on March 20th between 10 a.m. and 12 p.m. The survey was conducted in the downtown area and included 47th Street to 54th Street and 49th Avenue to 52nd Avenue (Figure 2.1, Page 5; Appendix B). Parking spaces were quantified and separated into two main categories:

1. Metered
2. Non-Metered

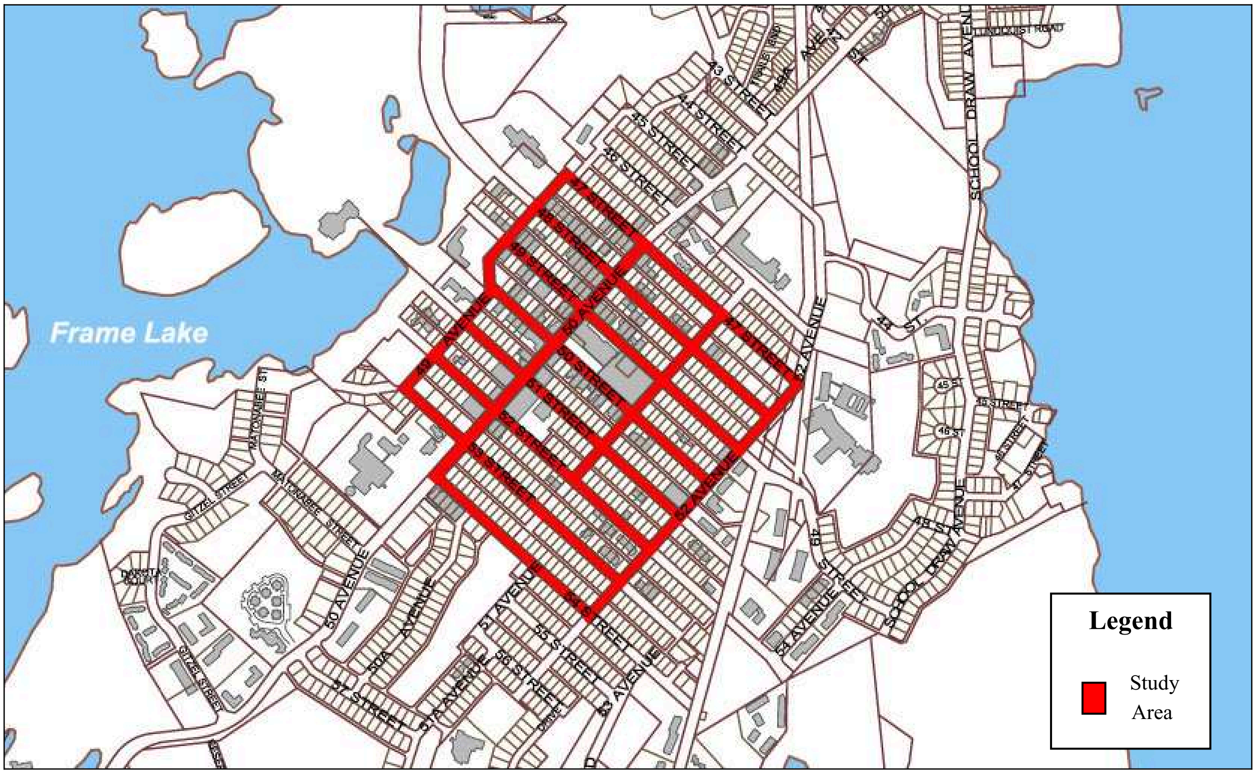



**Figure 2.1:**

**Area of Downtown Metered and Non-Metered Parking Survey**

## 2.4 Commuter Travel

Historic traffic counts from the City of Yellowknife Department of Public Works and Engineering were accessed for the locations where pedestrian and carpooling surveys were performed. Using this data, we were able to develop an approximate value for the different modes of transportation such as single-occupant vehicle commuter, carpool, pedestrian and bus commuters.

The City's traffic counts were taken during the summer months and, therefore, might underestimate the winter vehicle counts. Also, the most recent counts were from 1994. The value was increased by 10%, for growth purposes, for counts of traffic entering into the Downtown area. Approximately 54% of commuters were single-occupant commuters and about 28% of commuters carpooled to work, and 18% used either transit or some other form of active transportation.

# 3 ASSESSMENT

## 3.1 Annual Fuel Consumption and GHG Emissions

Terriplan estimated that total GHG emissions from Yellowknife in 2004 for the transportation sector were 359,500 tonnes of $CO_2$ and about 19% of the total GHG emissions from the City. The transportation sector includes all vehicle use that was derived from the purchase of gasoline and diesel from Yellowknife gas /service stations. The goal of this study is to determine ways that the City can best influence (decrease) GHG production and energy (fuel) demand. To understand what initiatives would work best, it is important to understand the different transportation modes that use fuel in Yellowknife. Some of these transportation modes cannot be influenced by the City. These are:

- Winter road traffic traveling to the mines in January to March of each year. This is a significant portion (14%) of the total diesel fuel consumed in Yellowknife. All trucks used to transport the goods to the mine sites refuel in Yellowknife.
- Transport trucks coming from the south to Yellowknife. Most of these trucks refuel in Alberta and are able to complete the roundtrip back to Alberta without refueling in Yellowknife. However, approximate 5% of the vehicles do refuel in Yellowknife.
- The Department of Transportation conducts traffic counts for Highway 3 which records the number of people drive out of Yellowknife each year toward Fort Providence. These vehicles consume fuels purchased in Yellowknife for these trips.

Other transportation modes maybe influenced by the City. These include;

- Recreational vehicles, such as snowmobiles and All Terrain Vehicles (ATV) consume fuels and produce GHG. It is difficult to determine an exact value for the fuel consumed. The estimates were based on the Terriplan report.
- Heavy Vehicles include local construction vehicles, sewer and water trucks, garbage trucks, commercial 5 and 10 tonne, etc. These vehicles are used for commerce.
- City bus mileage and fuel consumption was estimated by directly contacting Cardinal Bus Lines' mechanics.
- City taxi mileage and vehicle numbers were estimated by contacting taxi companies.
- Personal vehicle use for commuting to and from work,
- And personal vehicle use that is not commuter based.

**Table 3.1** (page 7) shows the breakdown of the fuel consumption for each transportation mode.

**Table 3.1:**

**Fuel Used by Transportation Mode**

| **Transportation Mode** | **Diesel (L)** | **Gasoline (L)** |
|---|---|---|
| | 14,317,000[2] | 11,650,000[3] |
| Transport truck (excluding Winter road) | 3,800,000 | N/A |
| Winter Road (January to March) | 2,043,796 | N/A |
| Highway 3 Daily Traffic | 1,854,930 | 1,517,670 |
| Recreational Vehicles (i.e. ATV, snowmobile) | N/A | 559,367 |
| Heavy Vehicles (construction vehicles, sewer and water trucks etc) | 4,455,500 | 234,500 |
| City Bus | 81,120 | N/A |
| Taxis | N/A | 860,239 |
| Fuel used for Personal Vehicle Use[4] | 2,081,654 | 8,478,224 |

[2] Quote from the *Terriplan and Pembina Institute for Appropriate Development, City of Yellowknife Energy and Emissions Baseline. City of Yellowknife* Report

[3] Quote from the *Terriplan and Pembina Institute for Appropriate Development, City of Yellowknife Energy and Emissions Baseline. City of Yellowknife* Report

[4] The personal use vehicle number if the difference between the total fuel purchased in Yellowknife and the estimated values for the modes in the table above.

**Figure 3.1:**

**Chart of Vehicle Transportation Modes for Gasoline**

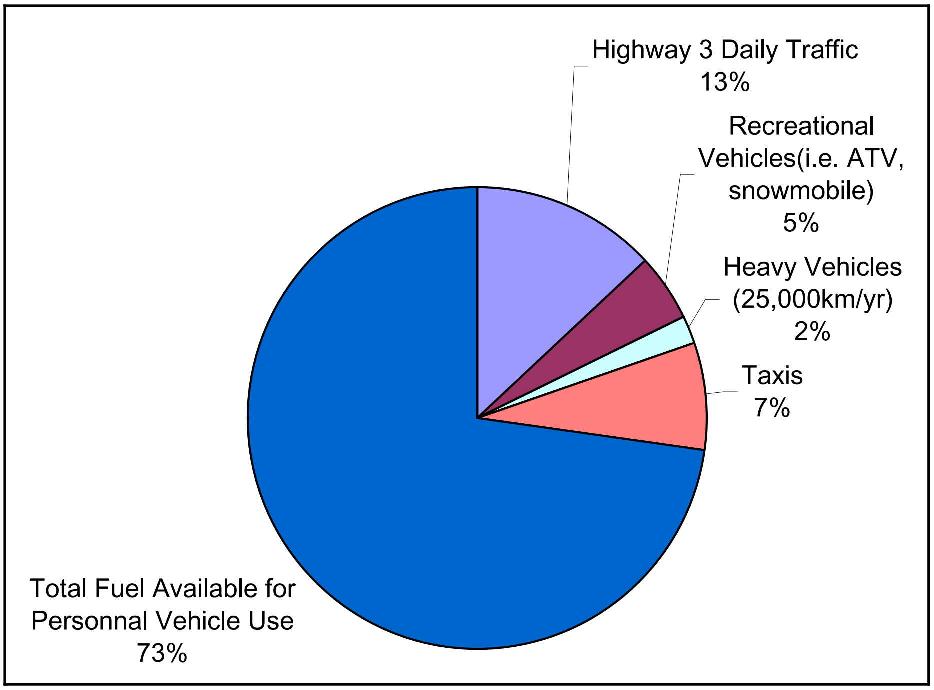



**Figure 3.2:**

**Chart of Vehicle Transportation Modes for Diesel**

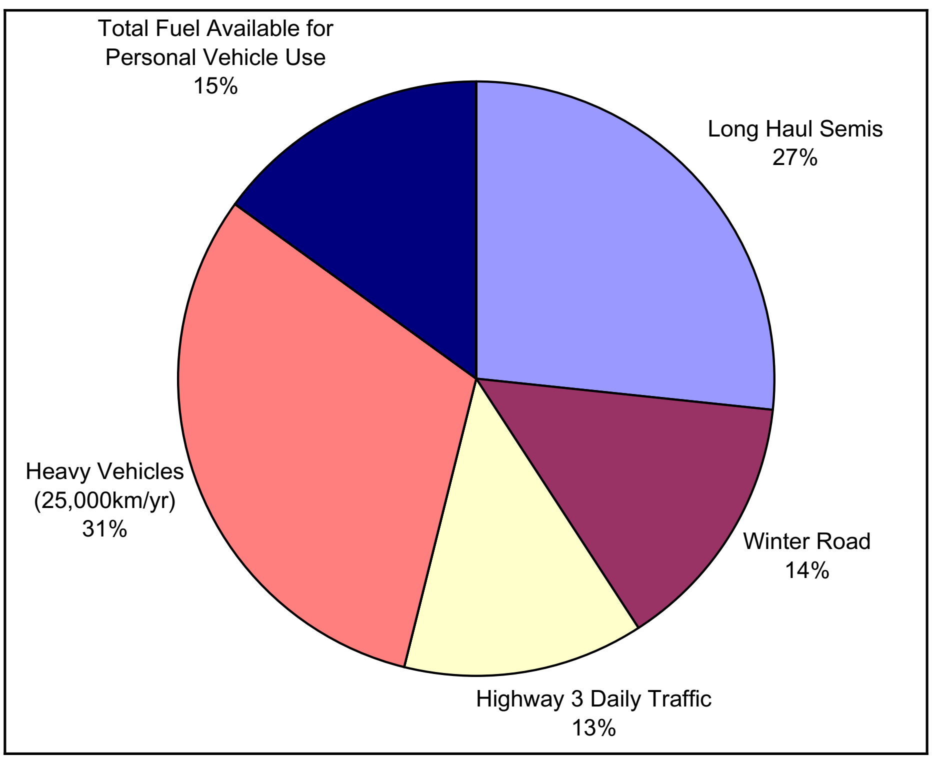
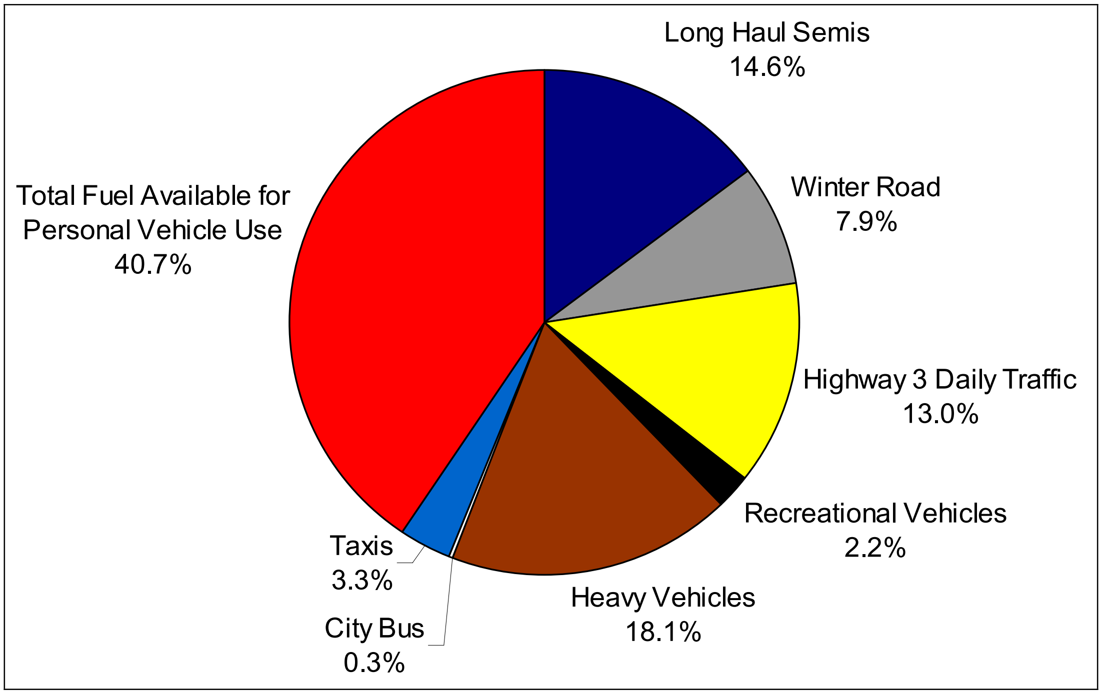


**Figure 3.3**

**Chart of Vehicle Transportation Modes for all fuels**




The previous work by Terriplan estimated that the total GHG emissions of the transportation sector is 359,500 tonnes of $CO_2$. From the above chart (Figure 3.2), it is clear that nearly 50% of this total is used during the transport of material to and from Yellowknife and by industry within the City. Personal use of vehicles, including recreational vehicles, accounts for the other 50% or approximately 9% the total $CO_2$ emissions from Yellowknife.

### *3.1.1 Commuter GHG Emissions*

The following table shows the commuting distance to and from a variety of areas in Yellowknife. The average roundtrip commute is approximately 6.3 km based on the average distance from the residential areas to the City center.

**Table 3.2:**

**Commuting Distances**

| Distance (km) | Latham Island | Old Town | Niven | Downtown | Northlands | Range Lake South | Kam Lake | Range Lake North | Airport |
|---|---|---|---|---|---|---|---|---|---|
| Latham Island | | 0.5 | 2.4 | 2.4 | 4.0 | 5.8 | 6.2 | 6.8 | 8.8 |
| Old Town | 0.5 | | 1.9 | 2.0 | 3.6 | 5.4 | 5.7 | 6.3 | 8.3 |
| Niven | 2.4 | 1.9 | | 1.4 | 3.1 | 5.0 | 5.3 | 5.9 | 7.8 |
| Downtown | 2.4 | 2.0 | 1.4 | | 1.6 | 3.4 | 3.7 | 4.3 | 6.3 |
| Northlands | 4.0 | 3.6 | 3.1 | 1.6 | | 1.8 | 2.1 | 2.7 | 4.8 |
| Range Lake South | 5.8 | 5.4 | 5.0 | 3.4 | 1.8 | | 1.5 | 1.7 | 4.7 |
| Kam Lake | 6.2 | 5.7 | 5.3 | 3.7 | 2.1 | 1.5 | | 3.3 | 6.6 |
| Range Lake North | 6.8 | 6.3 | 5.9 | 4.3 | 2.7 | 1.7 | 3.3 | | 2.7 |
| Airport | 8.8 | 8.3 | 7.8 | 6.3 | 4.8 | 4.7 | 6.6 | 2.7 | |

Using the estimated daily commute distance of 6.3 km and historic traffic counts, the commute is calculated as accounting for 6% of the total transportation sector, or 3.8 kilotonnes of $CO_2$ per year. Approximately 27 kilotonnes of $CO_2$ emitted annually from vehicles results from other non-work related use such as recreation use, shopping and other travel.

Comparatively, this is a very low percentage of total vehicle use for commuting when assessed against the rest of Canada. The primary reason is the short distances for commuting to and from work. This issue is a recurring theme throughout the assessment. In our assessment some of the initiatives focus on the commuters. These include;

- The transit system and adjustments to that system
- The use of active transport as an alternative to vehicle use
- And the use of small and fuel efficient vehicles.

However all initiatives impact total vehicle use and are not specific to the commute. Figure 3.5 below illustrates the varying fuel consumption and GHG production for the various commonly used vehicles.

**Figure 3.4:**

**Seating Capacity and $CO_2$ Emissions per Seated Passenger per Kilometer for Different Passenger Vehicles**

| | Passenger Seating | kg $CO_2$/ Person/km |
|---|---|---|
| 20 Seat MiniBus | 20 | 0.016 |
| B-20 Biodiesel City Bus | 45 | 0.020 |
| City Bus (45 Seat) | 45 | 0.023 |
| Passenger Van | 14 | 0.024 |
| Hybrid Car | 4 | 0.027 |
| MiniVan | 6 | 0.043 |
| Car | 5 | 0.044 |
| Gas | 5 | 0.064 |
| Diesel | 5 | 0.064 |

## 3.2 Transportation Mode Selection

### *3.2.1 Impacts of Commuter GHG - Overview*

To properly assess the factors that people use in choosing their transportation mode, you must considered financial costs, environmental costs and convenience to the transportation mode. It was assumed that commuters and personal vehicle owners consider the financial and convenience aspects of their daily commute above the environmental aspects.

A commuter driving an average of 6.3 km/workday will spend between \$180 and \$260 annually on fuel. In comparison, a commuter would spend \$62 dollars/month on a bus pass or \$744 dollars annually. It has been suggested that the cost of commuting should bare costs associated with operating a vehicle other than just fuel. The addition of an annual maintenance (\$150) and an allowance for plugging the vehicle in over the winter months (\$100 per annum) results in an annual vehicle cost in the range of \$450. This cost is still lower than using the transit system.

Clearly there is a cost to owning a vehicle. There is the capital (purchase) cost, the cost of insurance and the cost of annual maintenance. However, in background research it was found most households own a vehicle. Once the person owns the vehicle, he or she is financially more prudent to drive to work rather than commute by bus. Based on assessment, one of the barriers to the use of transit is the cost.

Alternatively, the typical bus rider is either a non-vehicle owner or chooses to ride the bus for environmental reasons.

Figure 3.4 shows the production rates of CO $CO_2$/year/vehicle for a variety of vehicle. One issue with the transit system is that ridership numbers suggest that, other than at the time of the morning and evening commute, the buses drive most of the day with few passengers. While the per person GHG production is less per vehicle km for a full bus than a car, the low ridership numbers result in the transit system producing more GHG per km than other types of vehicles. Looking at some options:

- assuming that the ridership could be increased to maximum capacity for the morning and evening commute (70 to 75 people per bus) this would represent 71.9 kg of $CO_2$ savings per year person per kilometer (assuming the person currently uses a car) based on the decrease of the commuter cars. And assuming that on additional buses are required.
- Assuming a bus is currently operating half full today (22 people), and the commute is 6.3 km, then increasing the bus utilization to 45 persons represents a total annual saving of 10.2 tonnes of $CO_2$ savings per year.

The problem lies in the small average roundtrip commute, which is only 6.3 km. Such a small commute results in a low $CO_2$ contribution by commuters relative to other cities. Meanwhile, a City bus may drive its route all day carrying few passengers. (See section 3.2.4 on the use of mini-buses)

### 3.2.2 Impacts of Commuter GHG on Individuals

Personal vehicle commuters contribute about 3,822 tonnes of $CO_2$ per year in Yellowknife. Should commuters choose to use the bus for their commute to work, it would require 70 commuters discontinue the use of their personal vehicle and use the bus to offset the GHG emissions resulting from the bus. The maximum capacity of City buses is 70 people. It costs 40% (see discussion section 3.2.1) more daily to take the bus to and from work than it does to drive. Parking data suggests that there are ample free parking spaces in the downtown should a person wish to walk an extra block.

The data suggests that the environmental trade-offs between mass transit and using a personal vehicle to commute are minimal and greatly depend on transit use increases. In other city centers transit use has been shown to be marginally dependant on price. In Yellowknife it is less costly for vehicle-owning commuters to drive to work. As a result, the financial cost and inconvenience (perceived or real) of taking the bus would very likely deter individuals who own a vehicle from using the transit system to commute roundtrip.

If commuters chose to use "Active" means of transportation such as skiing, walking, or biking, they would save about $230 in annual fuel costs. They would also reduce $CO_2$ emissions by 0.5 tonnes/year per person. In fact, if 10% of personal vehicle commuters used active transportation, it would save 382 tonnes of $CO_2$ annually.

### 3.2.3 Idling

Idling is believed to be a major contributor of GHGs. According to NRCan, a person who leaves their vehicle idling for 10 minutes a day wastes 100L of gas a year and 246 kg of $CO_2$ a year. Daily, it costs 30¢ worth of fuel to idle a vehicle for 10 minutes or about $110 a year to idle a vehicle for 10 minutes a day. In the winter people may idle longer than 10 minute to warm their vehicles, however for 2/3 of the year there is little need to idle. Our assumption is that people will idle for 20 to 30 minutes in the winter, and not idle in the summer. For in city travel, we have used the fuel consumption data for city driving which includes the time spent idling at stop sign, traffic lights etc.

The added costs of idling are minimal when included into a commuting context.. When the cost of idling is added to cost of commuting, a typical commuter would spend between $1.01 and $1.31 on fuel daily. Monthly, the extra cost of idling increases commuting by $6, but the total monthly cost of driving is still less that $30 monthly for most trucks and Sports Utility Vehicle (SUV), less than half the cost of a bus pass.

Although the financial cost of idling does not contribute greatly to cost of commuting, it does needlessly contribute to $CO_2$ emissions. The City has a No Idling By-law. It is difficult to determine the scale to which the By-law impacts $CO_2$ emissions. The By-Law as currently worded is difficult to enforce, and allows idling for when ambient air temperatures are below - 20 degrees.

#### *3.2.4* Change to Minibuses

The existing transit system uses a 45 person bus. The buses are used by commuters during the morning and evening "rush hour". However ridership information indicates that transit use outside of the work commute is very low. The use of a 45 passenger bus during non commuter periods is highly inefficient. Each City bus emits approximately 38 tonnes of $CO_2$ annually, and much of this (70 to 80 of the running time) is at a very low efficiency because of the lower ridership in the non commute hours.

The impact of utilizing smaller buses instead of the large buses currently in use was examined. An example of the type of minibus that was considered is a 20 passenger Ford E-450 Cutaway Shuttle Bus. For the use of a minibus the GHG production is determined as follows:

- A bus travels 36,000 km per year (the average mileage of current city buses)
- The mini buses consumes 4,070 L of diesel a year
- The mini Produces 11.4 tonnes of $CO_2$ per year compared to the 38 tonnes of $CO_2$ annually for the larger buses.
- The use of mini buses would result in a reduction to 30% of current GHG production for the transit system.

The capacity of the minibuses may not meet the rush hour demand. Minibuses can replace the larger buses during times of low ridership. If minibuses replaced the large city buses in non peak hours on weekdays and on the weekends the City could save approximately 86 tonnes of $CO_2$ emissions per year.

### 3.3 Energy Efficient Vehicles

There are a wide range of energy efficient vehicles on the market and in development. These include conventional powered vehicles like the Smart Car, hybrid vehicles, alternative fuel vehicles and prototypes (the Air Car).

The use of high mileage vehicles is not prevalent in the north. Typically there are a higher number of SUV and trucks in the north than in southern locations. There is no data available that provides a reason for this. One of the more popular and accessible fuel-efficient vehicles are the two-seat Smart Cars (which currently are operating in Yellowknife successfully). These cars have diesel engines and have about the same fuel efficiency as a hybrid-gasoline vehicle. Smart Cars cost approximately $16,700. They produce about 50% less $CO_2$ than conventional mid-sized vehicles. Some conclusions that can be drawn about Yellowknife drivers who tend toward larger vehicles:

- The consumer is not price sensitive. SUVs and trucks are higher price vehicles over the compact car.
- The consumer is purchasing a vehicle for reasons other than the daily commute. Recreation and lifestyle may be a factor. The ability to tow and trailer (boat or snowmobile) to pursue recreational activities may be a driving factor.
- The consumer may be concerned with perceived reliability and durability of the vehicle purchased in the northern climate.

Hybrid vehicles use both a conventional internal combustion engine and an electric engine. The capital cost of a hybrid vehicle is between $6,000 and $10,000 dollars more than conventional vehicles of similar model. However, hybrid vehicles on the market are less expensive than the typical SUV. In summary, hybrid vehicles:

- Use 50% less fuel
- Produce 50% less GHG
- Cost more than an equivalent vehicle but less than a typical SUV or truck
- Require over 10 years for fuel savings to pay off the initial cost of the vehicles for a typical Yellowknife driver, see Table 3.3, page 15.

The use of hybrid vehicles for taxis, which on average drive 100,000 km/yr/vehicle, would have a pay back of 1 to 2 years. The resulting GHG reduction from hybrid taxis would result in 912 tonnes $CO^2$/year decrease in total GHG emissions.

Another relatively recent addition to the low-emissions vehicle market is the Air Car[4]. At speeds of 50km/hr or less the car is powered by compressed air. At speeds greater than 50km/hr, an internal combustion engine is used. These vehicles emit no emissions at the lower speed. The exhaust is cold air which can be used for air conditioning. The vehicle is refilled at compressed air stations or an internal pump can be plugged in to an electrical outlet to refill the air tanks. A full tank lasts for 200km.

Depending on the use, these vehicles can operate without producing GHG. However, there maybe GHG production from diesel and power generation used to recharge the air tank. Over 2 tonnes of $CO_2$ production (based on current estimated annual mileage) can be saved annually for every Air Car that replaces a conventional vehicle in Yellowknife, and over 21 tonnes of $CO_2$ would be saved annually for every conventionally-powered taxi replaced by an Air Car. If all of the taxis were replaced with Air Cars, Yellowknife would reduce its in-city transportation-derived $CO_2$ emissions by 6.1%.

Six-seat Air Cars, called the Citycat, are expected to cost under $20,000 and fuel-costs are about 1¢/km. Air Cars are not currently available commercially.

[4] See http://www.theaircar.com/thecar.html

**Table 3.3**

**Comparison of Alternative Vehicle Types**

| Alternative Vehicle Type | Cost ($) | Availability | Seating Capacity | Fuel | Fuel Cost/ 1000 km | Emissions/10,000km Tonne/$CO_2$/Year | Comments |
|---|---|---|---|---|---|---|---|
|   | $26,000 to $31,500 | Immediate | 5 | Gasoline | $44.35 | 1.1 | Expensive, but cost-effective for livery industry. |
|   | $18,221 | Prototypes finished, Full-Scale Production Unknown | 6 | Compressed Air; Gas Above 50km/hr | $10.60 | 0 exhaust emissions; Energy production emissions for plug-in refill | For city driving, 0 exhaust emissions: cold air. Taxi version offered. |
|   | $16,700 | Immediate | 2 | Diesel | $43.94 | 1.2 | Suitable for Personal Use, but too few seats for livery industry |
|   | $15,000 to $40,000 | Immediate | 5 | Gasoline/ Diesel | $92.84 | 2.1 | None |
|   | $30,000 to $50,000 | Immediate | 5 | Gasoline/ Diesel | $136.29 to $118.84 | 3.1 to 3.2 | None |

### 3.4 Biodiesel

City buses produce as much GHG emissions as 70 commuting vehicles annually. Although more efficient fuels are being researched for buses (i.e. fuel cells), few are available for mass production and there is little or no infrastructure available in Yellowknife to support these fuels. Biodiesel and biodiesel mixtures are beginning to be tested in bus transit systems in Saskatoon and Montreal. In discussion with these jurisdictions, the program has been successful. Should the City decide to adopt a B-20 biodiesel [5] the city could save 34 tonnes of $CO_2$/year on total GHG emissions. B-20 biodesiel is the most commonly used type of bio-diesel available.

### 3.5 Commuter Email Survey

Our attempts to solicit responses via email yielded 11 responses: too few to make any conclusions or overarching assumptions. More than half of the 11 respondents walked to work and, of those who drove to work in the winter, switched to walking in the summer.

### 3.6 Parking Meter Survey

A parking survey was conducted on March 20th between 10 a.m. and 12 p.m. to determine the ratio and use of metered parking to non-metered parking in the City's downtown core (Figure 1, page 5). This survey was done to determine how an increase in the cost of downtown parking meters would affect commuters. Results from the survey found that only about 55% of the parking spots in the downtown area were metered. The survey also determined that only 51% of the metered spaces were used, while 59% of the non-metered parking was unused. The results of the parking meter survey indicate that a parking meter rate hike would not affect commuter habits since there is a large amount of free parking spaces in the downtown area.

### 3.7 Active Transport

When looking at individual transportation use, the greatest reduction to GHG production is when a vehicle is not purchased. The second greatest reduction is when the vehicle does not leave home. During the presentation to the Community Energy Planning Committee (April 11, 2006) the above two concerns were raised. The question from this meeting became; "How to get people to not use their vehicles?" The overall conclusion from the discussions is that there is no one single answer. There are a large number of options that residents can be engaged in to increase the amount of active transport, and decrease the vehicle miles driven. These items were divided into two groups:

1. Incentives included;
    a. Making improvements and expansions to the trail and bike route system.
    b. Keeping the sidewalks well maintained (repairs pot holes, remove snow and ice).
    c. Promoting "walking School Buses" amongst community parents
    d. Promoting and encouraging commuter challenges.

[5] 20% biodiesel, 80% petroleum diesel

2. Disincentives including;
    a. Increasing the cost of downtown parking
    b. Closing some streets and/or lanes to vehicle travel (also makes pedestrian travel more appealing)
    c. Increase vehicle registration costs.

(See Table 3.3, page 17)

**Table 3.4**

**Active Transportation**

| Incentives | Disincentives |
|---|---|
| Walking School buses" where school children walk together to school. This replaces the parent driving hem to school | Increase vehicle registration fees for large vehicles |
| Buddy system for walking to work | Add gas Tax |
| Promote commuter challenges | Designate bicycle lanes that remove car lanes |
| Establish Bike Routes where Bikes have the right of way | |
| Increase maintenance on sidewalks and trails in both winter and summer | |
| Maintain a compact City development theme | |
| Implementation of the City's Park, Trails and Open Space Plan | See appendix A |

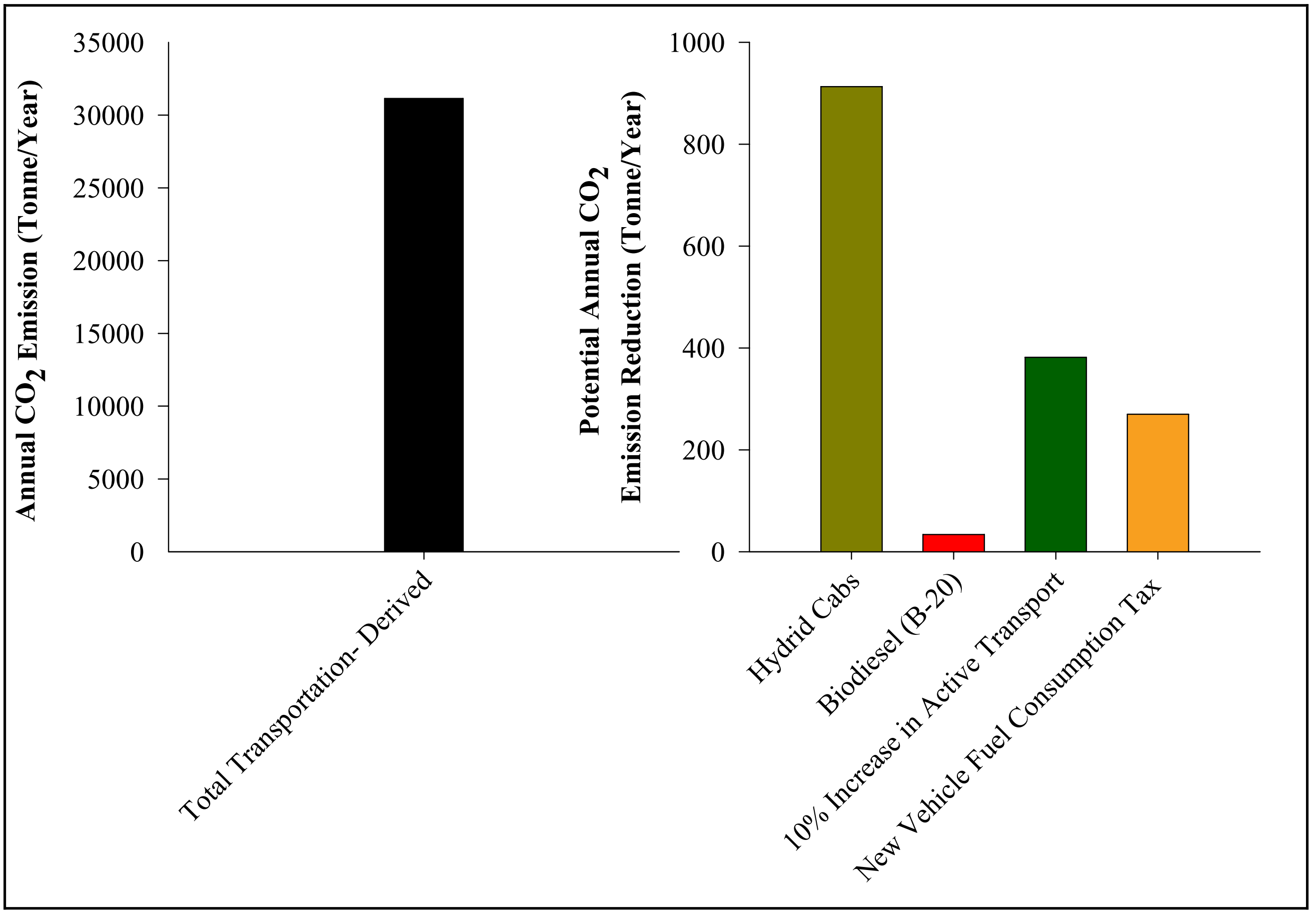
### 3.8 Summary of Assessment

Many of the suggestions listed in the appendix of the *Community Energy Planning Committee Report on Energy Expert "Roundtable"* were examined to determine how the ideas listed may impact transportation habits. Several of the suggestions are summarized on the following page, which includes the expected GHG savings from each idea and lists possible barriers to the implementation.

| List Of Initiatives - Public Round Table | Vehicle Use | | Can City Impact? | Gross Per Roundtrip GHG Savings (kg $CO_2$) | Gross Impact on Total Annual GHG Emissions (kg $CO_2$/Unit/Yr) | Comments |
|---|---|---|---|---|---|---|
| | Commute | Other | | | | |
| **Promote Use of Public Transit** **Includes GPS system to monitor bus location through internet.** | Yes | Yes | Yes | 2.1 | -541 | For vehicle owners, the added cost of driving to work is less than taking bus. |
| **Subsidize Transit System** **Includes Government Funding, Lower Bus fares, and Taxi voucher for frequent riders.** | Yes | Yes | Yes | 2.1 | -541 | Trust in the transit system; buses perceived as often late. Subsidized transit must cost less than non mass-transit costs. |
| **Electric Transit Buses** | Yes | Yes | Yes | 2.1/vehicle + bus emissions | -541/vehicle & -37,776/bus | No infrastructure in place. Does not take into account increased GHG emissions from power generation from Jackfish Station and Bluefish Dam. |
| **Employees Pay Minimally Into Plan for Work Buses** | Yes | No | Depends on Source of Subsidy | 2.1 | -541 | Similar to YK bus subsidies, must cost less than non-mass transit costs. |
| **Increase Cost of Downtown Parking** | Yes | Yes | Yes | 2.1 | -541 | Large supply of Non-Metered parking in the Downtown area will not stop people from parking farther and walking. |
| **More Frequent Buses** | Yes | Yes | Yes | 10.8 | -2812 | Dependent on passenger density and daily bus efficiency. The system requires a minimum 70 passengers per trip in peak hours to offset GHG emissions of bus travel over the day. Maximum bus capacity is 75 and it is expected that the decrease in emissions is negligible or actually increases rather than decreases if additional buses are added to the system as ridership increases. |
| **Other Initiatives** | | | | | | |
| **Encourage or Require All Taxis to be Hybrid Vehicles** | Yes | Yes | Through INcentives | 1.0 | -7312 | Large GHG emissions savings for livery industry; likewise, huge saving for GHG emissions due to transportation in Yellowknife, with a 2.9% GHG emissions reduction/Yr overall. Taxi vehicle pays itself off in 1 - 3 years with fuel cost savings. |
| **Use Biodiesel (i.e. B-20) in City Buses** | Yes | Yes | Yes | N/A | -5666 | Overall, switch buses to bio-diesel can save 0.1% on annual transportation-derived GHG emissions. |
| **Promote "Active" Transport** | Yes | Yes | Yes | 2.1 | -541 | Barriers exist, but not determined. |
| **Monitor Air Cars and Other Developing Technologies** | Yes | Yes | Yes | 2.1 | -541 | No full-scale production yet. |
| **Fuel Consumption Tax for New Vehicles** | Yes | Yes | Possibly, through by-law; GNWT | Minimal, Large Annual CO2 Reduction | Between 0.13 to 0.29, depending on vehicle type | Similar tax in place in Ontario of cars and SUVS. Based on highway fuel consumption. |

**Figure 3.6**

**Total Annual Transportation-Derived $CO_2$ Emissions and Potential $CO_2$ Emissions Reduction**



# 4 CONCLUSIONS AND RECOMMENDATIONS.

Most of the roundtable initiatives and the commentary from the Community Energy Planning Committee focused on the increased use of public transit and the increase in active transport. However, the assessment suggests that the GHG reduction from changes to the transit system is marginal. The greatest gains are found in the following areas:

1. Taxis switched to hybrid cars would reduce annual in-city transportation-derived $CO_2$ emissions of 31,141 tonnes. The benefits are not restricted to $CO_2$ emissions, rather, taxi companies could save between $3,000 and $6,000 annually in fuel. The fuel savings will likely increase in the future as the cost of fuel is expected to continue to rise.

**Recommendation;**
**The City to consider additional incentives through permit discount for Hybrid Taxis.**

2. Encourage citizens to purchase hybrid vehicles and high mileage vehicles. The perceived issues with these vehicles (reliability and durability in the northern climate) need to be overcome. A change to this vehicle choice will result in a $CO_2$ emissions reduction of around 0.6 to 0.8 tonnes annually per vehicle if people move from a pick up to a compact car, or from a compact car to a hybrid.

**Recommendation;**
**The City to initiate a pilot program with the use of a hybrid, possibly in conjunction with the GNWT.**

3. Switching the buses to B-20 biodiesel would result in a 0.1% decrease in its annual $CO_2$ emissions. Although this may seems minimal, each bus would emit roughly 5.7 tonnes of $CO_2$ less annually. Although the benefits of using biodiesel in buses may seem to have little impact on overall GHG emissions, it may be a large step in exposing the citizens of Yellowknife to green alternatives and technologies, especially since the transit system is a visible facet of the municipal government. .

**Recommendation;**
**The City to further investigate the use of Biodiesel for their vehicle fleet and transit system.**

4. The city should also assess mass transit demand to change its vehicle fleet accordingly. Minibuses and other transit alternatives can be used to reduce the GHG production. Minibuses require new fleet acquisitions and these would displace the use of the larger buses during non peak-times. The table below demonstrates the GHG emissions for various vehicle types based on full capacity. City buses, B-20 city buses, Minibuses, vans and cars all have different $CO_2$ emissions : passenger ratios based on capacity

**Recommendation;**
**The City should consider adding Minibuses to the transit fleet**

5. Active transport such as walking, biking or skiing would achieve the greatest gain in GHG reduction. A side benefit is it promotes healthy lifestyles since it involves physical activity. There are numerous ways in which the City of Yellowknife can promote Active transportation. They can encourage workplaces to partake in friendly competitions such as the Commuter Challenge where organizations compete against one another by using active transport or mass transit rather than driving to work. The City might also encourage walking by making more pedestrian or biking paths, or by making downtown and other areas more pedestrian friendly while discouraging vehicle use.

Improved maintenance or upgrading the Frame Lake trail system may also promote walking. Also, bike lanes along Franklin Street might promote bikers. Currently, there is little space to bike on Franklin Street which may be a disincentive to bike. Finally, the greatest impact on Active transport would be to create a compact city where many people live within walking or biking distance to work and shopping. Many people who drive live outside the downtown area in Range Lake North or South. The closer people live to the downtown area, the more likely they are to walk to work or shop.

**Recommendation;**
**The City to Promote Active Transport**

6. Encourage people to purchase fuel efficient vehicles through the implementation of a Fuel Consumption Tax for New Vehicles, or an annual registration tax which targets inefficient vehicles. Ontario has instituted such a tax which targets new cars and SUVs. New vehicles are taxed based on how far they deviate from the highway fuel consumption standard of 6L/100km for cars and 8L/100km for SUVs. The tax ranges from $75 dollars to $2400 dollars. Efficient vehicles which have fuel consumptions below the benchmark have rebates of $100. This falls under the territorial jurisdiction.

**Recommendation;**
**The City needs to work with the GNWT to implement this action.**

Although these recommendations do not impact GHG emissions in a large way, they require little extra infrastructure. Should the city implement all the recommendations and all prove to be successful, they could result in a reduction of 3,500 tonnes of $CO_2$ emitted annually in the City and reduced costs to the City related to energy demand. The table below illustrates the potential GHG reduction, and associated cost saving that could be attained through the above recommendation.

**Table 4.1**
**Summary of Recommendations**

| Recommendation | Annual GHG Reduction (tonne $CO_2$/year) | Annual $ Reduction of Fuel Use |
|---|---|---|
| The City to consider additional incentives through permit discount for Hybrid Taxis | 910 | $400,000 |
| The City to initiate a pilot program with the use of a hybrid, possibly in conjunction with the GNWT | 1.4 – 0.7 per unit | $610 – $320 per unit |
| The City to further investigate the use of Biodiesel for their vehicle fleet and transit system | 34 | N/A |
| The City should consider adding Minibuses to the transit fleet | 85 | $33,000 |
| The City to Promote Active Transport | 380 | $170,000 |
| The City needs to work with the GNWT to implement this action | 270 | $120,000 |

# 5 RESOURCES

City of Yellowknife and the Arctic Energy Alliance. City of Yellowknife Interim Community Energy Plan. City of Yellowknife.

Ecology North. Ecology North Walking Forum. Ecology North: Yellowknife.

Natural Resources Canada. Office of Energy Efficiency, For Personal Use: Transportation. http://oee.nrcan.gc.ca/transportation/personal/index.cfm?attr=0. Accessed March 16th to April 19th, 2006.

Robinson, Andrew. Report on Energy Expert "Roundtable" Held on July 12, 2005: Revised with Input from Yellowknife CEP Committee. Yellowknife Community Energy Planning Committee.

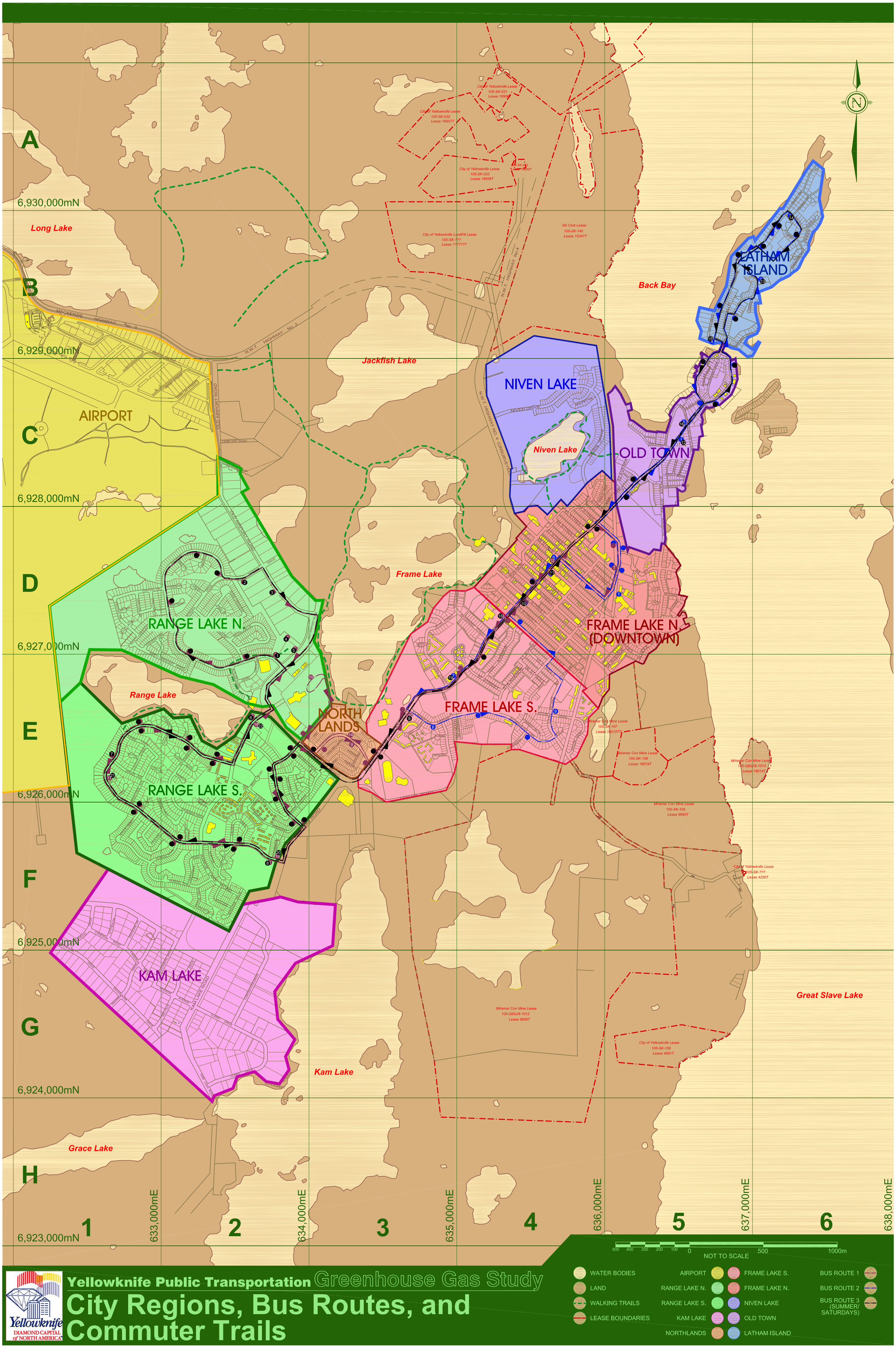
Statistics Canada. Gasoline and fuel oil, average retail prices by urban centre (monthly) – Yellowknife. http://www40.statcan.ca/l01/cst01/econ152r.htm. Accessed March 21st, 2006.

Terriplan Consultants and Pembina Institute for Appropriate Development. City of Yellowknife Energy and Emissions Baseline. City of Yellowknife.

The Air Car. http://www.theaircar.com/. Accessed April 20th - 21st, 2006.

# APPENDIX A

## City Maps, Bus Routes, and Commuter Trails




**Yellowknife Public Transportation** Greenhouse Gas Study

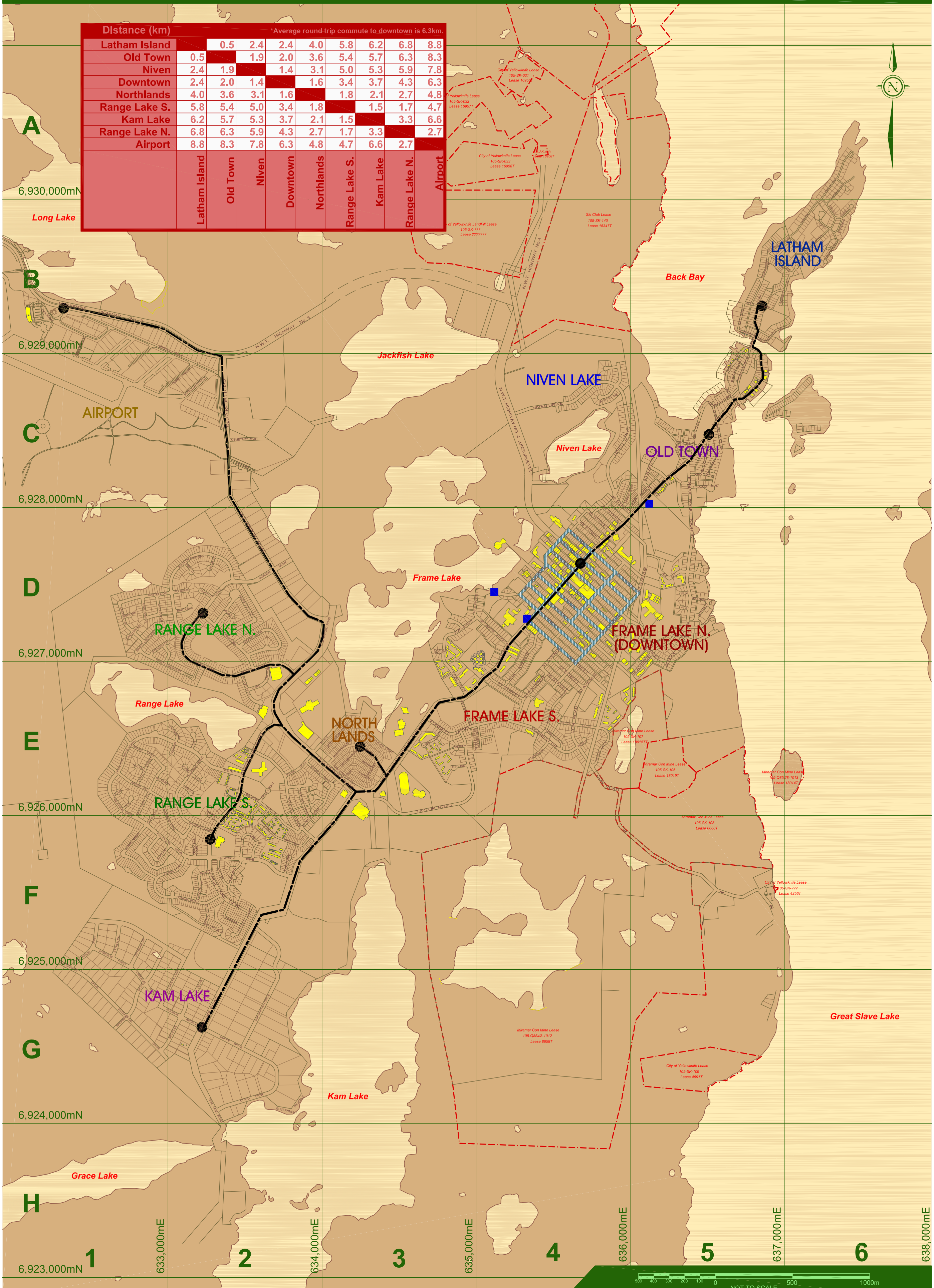
# City Regions, Bus Routes, and Commuter Trails

# APPENDIX B

## Commute Routes, Downtown Meter Monitoring Survey Area, and Traffic Count Locations

| Distance (km) | Latham Island | Old Town | Niven | Downtown | Northlands | Range Lake S. | Kam Lake | Range Lake N. | Airport |
|---|---|---|---|---|---|---|---|---|---|
| Latham Island | | 0.5 | 2.4 | 2.4 | 4.0 | 5.8 | 6.2 | 6.8 | 8.8 |
| Old Town | 0.5 | | 1.9 | 2.0 | 3.6 | 5.4 | 5.7 | 6.3 | 8.3 |
| Niven | 2.4 | 1.9 | | 1.4 | 3.1 | 5.0 | 5.3 | 5.9 | 7.8 |
| Downtown | 2.4 | 2.0 | 1.4 | | 1.6 | 3.4 | 3.7 | 4.3 | 6.3 |
| Northlands | 4.0 | 3.6 | 3.1 | 1.6 | | 1.8 | 2.1 | 2.7 | 4.8 |
| Range Lake S. | 5.8 | 5.4 | 5.0 | 3.4 | 1.8 | | 1.5 | 1.7 | 4.7 |
| Kam Lake | 6.2 | 5.7 | 5.3 | 3.7 | 2.1 | 1.5 | | 3.3 | 6.6 |
| Range Lake N. | 6.8 | 6.3 | 5.9 | 4.3 | 2.7 | 1.7 | 3.3 | | 2.7 |
| Airport | 8.8 | 8.3 | 7.8 | 6.3 | 4.8 | 4.7 | 6.6 | 2.7 | |

*Average round trip commute to downtown is 6.3km.




Yellowknife DIAMOND CAPITAL of NORTH AMERICA

**Yellowknife Public Transportation** Greenhouse Gas Study

# Commute Routes, Meter Monitoring, and Traffic Count Locations

# APPENDIX C

# CEP ACTION AREA 2 WORKSHEET

| Distance (m) | Latham Island | Old Town | Niven | Downtown | Northlands | Range Lake South | Kam Lake | Range Lake North | Airport |
|---|---|---|---|---|---|---|---|---|---|
| Latham Island | | 460 | 2410 | 2443 | 4010 | 5833 | 6152 | 6754 | 8775 |
| Old Town | 460 | | 1950 | 1982 | 3550 | 5373 | 5691 | 6294 | 8315 |
| Niven | 2410 | 1950 | | 1405 | 3138 | 4960 | 5279 | 5881 | 7802 |
| Downtown | 2443 | 1982 | 1405 | | 1568 | 3391 | 3709 | 4311 | 6332 |
| Northlands | 4010 | 3550 | 3138 | 1568 | | 1823 | 2141 | 2743 | 4765 |
| Range Lake South | 5833 | 5373 | 4960 | 3391 | 1823 | | 1548 | 1737 | 4720 |
| Kam Lake | 6152 | 5691 | 5279 | 3709 | 2141 | 1548 | | 3286 | 6616 |
| Range Lake North | 6754 | 6294 | 5881 | 4311 | 2743 | 1737 | 3286 | | 2681 |
| Airport | 8775 | 8315 | 7802 | 6332 | 4765 | 4720 | 6616 | 2681 | |

| Average Round Trip Commute to Downtown | |
|---|---|
| m | km |
| 6285 | 6.3 |

| Distance (km) | Latham Island | Old Town | Niven | Downtown | Northlands | Range Lake South | Kam Lake | Range Lake North | Airport |
|---|---|---|---|---|---|---|---|---|---|
| Latham Island | | 0.5 | 2.4 | 2.4 | 4.0 | 5.8 | 6.2 | 6.8 | 8.8 |
| Old Town | 0.5 | | 1.9 | 2.0 | 3.6 | 5.4 | 5.7 | 6.3 | 8.3 |
| Niven Lake | 2.4 | 1.9 | | 1.4 | 3.1 | 5.0 | 5.3 | 5.9 | 7.8 |
| Downtown | 2.4 | 2.0 | 1.4 | | 1.6 | 3.4 | 3.7 | 4.3 | 6.3 |
| Northlands | 4.0 | 3.6 | 3.1 | 1.6 | | 1.8 | 2.1 | 2.7 | 4.8 |
| Range Lake South | 5.8 | 5.4 | 5.0 | 3.4 | 1.8 | | 1.5 | 1.7 | 4.7 |
| Kam Lake | 6.2 | 5.7 | 5.3 | 3.7 | 2.1 | 1.5 | | 3.3 | 6.6 |
| Range Lake North | 6.8 | 6.3 | 5.9 | 4.3 | 2.7 | 1.7 | 3.3 | | 2.7 |
| Airport | 8.8 | 8.3 | 7.8 | 6.3 | 4.8 | 4.7 | 6.6 | 2.7 | |

Info From NRCAN's http://oee.nrcan.gc.ca/transportation/idling/issues/why-idling-problem.cfm?attr=8#wastes website

10 minutes = 100L/year

| L/day | L/minutes idling |
|---|---|
| 0.27 | 0.03 |

| Cost/day | Cost/Minute |
|---|---|
| $0.30 | $0.03 |

| Gasoline | CO2 (kg/Yr) |
|---|---|
| 100L= | 246 |

## Smart Cars

| | Fuel Efficiency | | | | | CO2 Emissions | | | |
|---|---|---|---|---|---|---|---|---|---|
| | City | Highway | City | Highway | Average | Commute | | Total Annual Use | |
| Base Model Cost | L/100km | L/100km | km/L | km/L | km/L | kg/yr/unit | tonne/yr/unit | kg/yr/unit | tonne/yr/unit |
| $16,700.00 | 4.6 | 3.8 | 21.7 | 26.3 | 23.8 | 191.9 | 0.2 | 774.0 | 0.8 |

| Average Annual CO2 emission for a light Vehicle |
|---|
| tonne/yr |
| 1.98 |

| 10% Transportation-Derived $CO_2$ Reduction | Amount of Light Vehicle Owners Needed to Switch to Smart Cars to Meet 10% Emissions Reduction |
|---|---|
| 3,114 | 2577 |

## AIR CAR

| Est. Cost of City Cat | Refill cost | distance (km) / refill | cost/km | cost/ 100km |
|---|---|---|---|---|
| 18,221 | 2.11 | 200 | $0.01 | $1.06 |

| Total Annual Cost (6592 km/yr) | Amount of Light Vehicle Owners Needed to Switch to Air Cars to Meet 10% Emissions Reduction |
|---|---|
| $70 | 1571 |

## Alternative Vehicle Comparison

| | Refill cost | distance/ refill | cost/ km | cost/ 1000km |
|---|---|---|---|---|
| Hybrid | 48.8 | 1101 | $0.04 | $44.35 |
| Smart Car | 28.2 | 643 | $0.04 | $43.94 |
| Air Car | 2.1 | 200 | $0.01 | $10.55 |
| Standard Car (Gas) | 65.10 | 701 | $0.09 | $92.84 |
| Standard Truck (Gas) | 108.50 | 796 | $0.14 | $136.29 |
| Standard Truck (Diesel) | 104.58 | 880 | $0.12 | $118.84 |

## Emissions

| kg/km | kg/10000km | tonne/10000km |
|---|---|---|
| 0.1 | 1111.8 | 1.1 |
| 0.1 | 1184.7 | 1.2 |
| 0 | 0 | 0 |
| 0.2 | 2104.7 | 2.1 |
| 0.3 | 3089.7 | 3.1 |
| 0.3 | 3175.1 | 3.2 |

| List Of Initiatives - Public Round Table | Vehicle Use | | Can City Impact? | Gross Per Roundtrip GHG Savings (kg $CO_2$) | Per Trip Individual Net Costs | Gross Impact on Total Annual GHG Emissions kg $CO_2$/Unit/Yr | Comments |
|---|---|---|---|---|---|---|---|
| | Commute | Other | | | | | |
| **Promote Use of Public Transit**<br>*Includes GPS system to monitor bus location through internet.* | Yes | Yes | Yes | -2.1 | $4.11 | -541 | Individual costs associated with driving less than with taking bus. Specifically for individuals who already own a vehicle. |
| **Subsidize Transit System**<br>*Includes Government Funding, Lower Bus fares, Taxi voucher for frequent riders.* | Yes | Yes | Yes | -2.1 | N/A | -541 | Trust in the transit system; buses perceived as often late. Subsidized transit must cost less than mass-transit commuter costs. |
| **Electric Transit Buses** | Yes | Yes | Yes | -2.1/vehilce + bus emissions | N/A | -541/vehicle + -37,776/bus | No infrastructure in place. Does not take into account increased GHG emissions from power generation from Jackfish Station and Bluefish Dam. |
| **Employees Pay Minimally Into Plan for Work Buses** | Yes | No | Depends on Source of Subsidy | -2.1 | N/A | -541 | Similar to YK bus subsidies, must cost less than non-mass transit commuter costs. |
| **Increase Cost of Downtown Parking** | Yes | Yes | Yes | -2.1 | $4.11 | -541 | Large supply of Non-Metered Parking in the Downtown area, won't stop people from further and walking. |
| **More Frequent Buses** | Yes | Yes | Yes | -10.8 | $4.11 | -2812 | Dependent on passenger density. Require minimum 70 passengers to offset GHG emissions of bus; meanwhile, maximum bus capacity is 75, otherwise GHG emissions negligible or actually increases rather than decreases |
| **Other Initiatives** | | | | | | | |
| Encourage or Require All Taxis to be Hybrid Vehicles | Yes | Yes | Through Subsidies | -1.0 | $19.11 | -7312 | Large GHG emissions savings for livery industry; likewise, huge saving for GHG emissions due to transportation in Yellowknife, with a 2.9% GHG emissions reduction/Yr overall. Taxi vehicle pays itself off in 1 - 3 years with fuel cost savings. |
| Use Biodiesel (i.e. B-20) in City Buses | Yes | Yes | Yes | N/A | N/A | -5666 | Overall, switch buses to biodiesel can save 0.1% on annual Transportation derived GHG emissions. |
| Promote "Active" Transport | Yes | Yes | Yes | 2.1 | $0.00 | 541 | Barriers exist, but not Determined. |

| | |
|---|---|
| Total Personal Vehicle GHG Emissions - Tonne $CO_2$/Yr | 31,141 |
| Total Commuting GHG Emissions (Single Vehicle and Bus) - Tonne $CO_2$/Yr | 4,049 |
| Estimated Total Commuting Single-Occupant Vehicles | 7,415 |

| **Current Estimates** Total Commuting GHG Emissions Tonne $CO_2$/Yr | |
|---|---|
| Bus | Personal Vehicle |
| 227 | 3,822 |

| | |
|---|---|
| **Net Annual GHG Reduction Per Full Bus (70 Passengers) - Tonne $CO_2$/Yr** | -0.1 |

| **Transit Use Increase by Commuters - Net Change in Commuting $CO_2$ Emissions** | **Net $CO_2$ Emissions 1% ↓** | | **Net $CO_2$ Emissions 5% ↓** | | **Net $CO_2$ Emissions 10% ↓** | |
|---|---|---|---|---|---|---|
| | Number of Bus (Max Cap. 70) | Reduction in Vehicles | Number of Bus (Max Cap. 70) | Reduction in Vehicles | Number of Bus (Max Cap. 70) | Reduction in Vehicles |
| **Increase/Decrease In Commuting Vehicles** | 380 | -26609 | 1,901 | -133043 | 3,801 | -266086 |

| | Proportion (time) | CO2 Emissions (Tonne/Year) | % Reduction |
|---|---|---|---|
| City Bus (6:30-9:30 and 16:30-9:30) | 46% | 105 | 0.5% |
| Mini Bus (9:30-16:30) | 54% | 37 | |
| | Total | 141 | |

| | Fuel Supply (2004) | |
|---|---|---|
| | **Diesel** | **Gasoline** |
| | **L** | **L** |
| | **14,317,000** | **11,650,000** |
| Long Haul Semis | 3,800,000 | N/A |
| Winter Road | 2,043,796 | N/A |
| Highway 3 Daily Traffic | 1,854,930 | 1,517,670 |
| Recreational Vehicles (i.e. ATV, snowmobile) | N/A | 559,367 |
| Heavy Vehicles (25,000km/yr) | 4,455,500 | 234,500 |
| City Bus | 81,120 | N/A |
| Taxis | N/A | 860,239 |
| **Total Fuel Available for Personal Vehicle Use** | **2,081,654** | **8,478,224** |

| | | |
|---|---|---|
| **Person Vehicle Use (km/yr/vehicle)** | **12,745** | **6,592** |

| **Annual Commuting GHG Emissions per Vehicle (Tonne $CO_2$)** | Diesel | Gas |
|---|---|---|
| Passenger Car | | 0.4 |
| Passenger Van | | 0.6 |
| Light Utility Vehicle | | 0.6 |
| Pickup Truck | 0.5 | 0.6 |

| **Annual GHG Emissions per Personal Vehicle (Tonne $CO_2$)** | | |
|---|---|---|
| Passenger Car | | 1.4 |
| Passenger Van | | 2.0 |
| Light Utility Vehicle | | 2.0 |
| Pickup Truck | 4.0 | 2.0 |

| **Proportion of Annual Commuting GHG Emissions vs. Total Annual GHG Emission per Vehicle** | | |
|---|---|---|
| Passenger Car | | 30% |
| Passenger Van | | 30% |
| Light Utility Vehicle | | 29% |
| Pickup Truck | 13% | 29% |

| | |
|---|---|
| **Annual Impact of Commuter GHG Emissions on Total in City Transportation GHG Emissions (Tonne $CO_2$/Yr) (Personal Vehicles, Recreation Vehicles, City Buses)** | 12% |

| | | | | | |
|---|---|---|---|---|---|
| Lease Option for City | | | | | |
| | | | | | |
| 4 year | | | | | |
| model | monthly payments | annual total | annual fuel cost | annual saving | annual co2 redox (tonne) |
| prius | $626.08 | $7,512.96 | $286.11 | $414.86 | 0.6 |
| camry | $403.79 | $4,845.48 | $700.98 | $0.00 | |
| | | | | | |
| civic hybrid | $505.75 | $6,069.00 | $336.18 | $200.28 | 0.3 |
| civic | $318.06 | $3,816.72 | $536.46 | $0.00 | |

**PURCHASE HYBRID VEHICLES FOR CABS**

| | Registered Vehicles (2004) | Annual Fuel Use Total (L/yr) | $CO_2$ Emissions kg/Year | Tonne/Year | Tonne/yr/unit | % Reduction of Total GHG From Personal Vehicles/Taxis |
|---|---|---|---|---|---|---|
| Passenger Car | | | | | | |
| Taxis | 92 | 787,213 | 1,936,323 | 1,936 | 21.0 | 0.0% |
| Hybrid Vehicle | 92 | 416,152 | 1,023,618 | 1,024 | 11.1 | 2.9% |

**BUS ALTERNATIVE FUEL**

| BioDiesel (B-20) | Units (Buses In Use) | Total Annual Fuel Consumption (L/yr) | $CO_2$ Emissions kg/Year | Tonne/Year | Tonne/yr/unit | % Reduction of Total GHG From Buses |
|---|---|---|---|---|---|---|
| | 6 | 81,120 | 226,657 | 227 | 37.8 | 0.0 |
| | 6 | 81,120 | 192,659 | 193 | 32.1 | 0.1% |

**ACTIVE TRANSPORT**

| | Single Occupant Commuter CO2 Emission (kg/year) | Single Occupant Commuter CO2 Emission (tonne/year) | % Reduction of Total GHG From Single Occupant PV |
|---|---|---|---|
| | $CO_2$ Emissions | | |
| Current | 3,822,075 | 3,822 | 0 |
| 10% Personal Vehicle Shift to Active Means | 3,439,868 | 3,440 | 1.2% |

**MINI BUS (20 PASSENGER)**

| Distance - km/Month | Fuel Consumption km/L | L/yr | $CO_2$ Emission kg/year | tonne/year | GHG EMISSIONS RATIO Commuter Emissions: Bus Emissions |
|---|---|---|---|---|---|
| 3000 | 8.8 | 4,071 | 11,376 | 11.4 | 21 |

**FUEL CONSUMPTION TAX FOR NEW VEHICLES - GAS ONLY**

| | Standard - Highway Consumption L/100km | km/L | Adoption Rate - 10% Estimated Emissions Reduction kg/CO2/Year | Tonne/CO2/Year | % Reduction From Annual In-City Transportation-Derived CO2 Emission |
|---|---|---|---|---|---|
| Car | 6 | 12.9 | 70,069 | 70.1 | 0.9% |
| Truck, Van, SUV | 8.5 | 9.3 | 199,703 | 199.7 | |
| | | **TOTAL** | 269,772 | 270 | |

## Base Model Comparison

**Personal Vehicle**

| Manufacturer | Model | Hybrid | Vehicle Type | Base Price $ | Fuel Economy | | | | GHG Emissions | Initial Cost Difference ($) | Annual Fuel Cost | Annual Difference | | Years to Recover Initial Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L/100km | | L/km | | $CO_2$ kg/yr | Compared to | | Cost | CO2 Emissions | |
| | | | | | City | Hwy | City | Hwy | (6592 km/yr) | Conventional Engine | | | kg/unit/yr | |
| Honda | Civic | Yes | Compact | 25800 | 4.7 | 4.3 | 21.3 | 23.3 | 731.5 | $8,820.00 | $336.2 | -$200.3 | -333.3 | 44.0 |
| Honda | Civic | No | Compact | 16980 | 7.5 | 5.7 | 13.3 | 17.5 | 1064.9 | $0.00 | $536.5 | | | |
| | | | | | | | | | | | | | | |
| Toyota | Prius | Yes | Mid-Size | 31,280 | 4.0 | 4.2 | 25.0 | 23.8 | 662.8 | $5,480.00 | $286.1 | -$414.9 | -630.8 | 13.2 |
| Toyota | Camry | No | Mid-Size | 25,800 | 9.8 | 6.5 | 10.2 | 15.4 | 1293.6 | $0.00 | $701.0 | | | |
| | | | | | | | | | | | | | | |
| Toyota | Highlander | Yes | SUV | 44,205 | 7.5 | 8.1 | 13.3 | 12.3 | 1258.1 | $6,350.00 | $536.5 | -$221.7 | -231.6 | 28.6 |
| Toyota | Highlander | No | SUV | 37,855 | 10.6 | 7.9 | 9.4 | 12.7 | 1489.7 | $0.00 | $758.2 | | | |
| | | | | | | | | | | | | | | |
| Ford | Escape | Yes | SUV | 33499 | 6.6 | 7.0 | 15.2 | 14.3 | 1098.5 | $10,500.00 | $472.1 | -$307.6 | -479.2 | 34.1 |
| Ford | Escape | No | SUV | 22999 | 10.9 | 8.6 | 9.2 | 11.6 | 1577.6 | $0.00 | $779.7 | | | |

**Taxis**

| Manufacturer | Model | Hybrid | Vehicle Type | Base Price $ | Fuel Economy | | | | GHG Emissions | Initial Cost Difference ($) | Annual Fuel Cost | Annual Difference | | Years to Recover Initial Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L/100km | | km/L | | $CO_2$ kg/yr | Compared to | | Cost | CO2 Emissions | |
| | | | | | City | Hwy | City | Hwy | (100000 km/yr) | Conventional Engine | | | kg/unit/yr | |
| Honda | Civic | Yes | Compact | 25800 | 4.7 | 4.3 | 21.3 | 23.3 | 11096.2 | $8,820.00 | $5,099.5 | -$3,038.0 | -5056.3 | 2.9 |
| Honda | Civic | No | Compact | 16980 | 7.5 | 5.7 | 13.3 | 17.5 | 16152.5 | $0.00 | $8,137.5 | | | |
| | | | | | | | | | | | | | | |
| Toyota | Prius | Yes | Mid-Size | 31,280 | 4.0 | 4.2 | 25.0 | 23.8 | 10054.3 | $5,480.00 | $4,340.0 | -$6,293.0 | -9568.0 | 0.9 |
| Toyota | Camry | No | Mid-Size | 25,800 | 9.8 | 6.5 | 10.2 | 15.4 | 19622.3 | $0.00 | $10,633.0 | | | |
| | | | | | | | | | | | | | | |
| Toyota | Highlander | Yes | SUV | 44,205 | 7.5 | 8.1 | 13.3 | 12.3 | 19084.0 | $6,350.00 | $8,137.5 | -$3,363.5 | -3513.5 | 1.9 |
| Toyota | Highlander | No | SUV | 37,855 | 10.6 | 7.9 | 9.4 | 12.7 | 22597.6 | $0.00 | $11,501.0 | | | |
| | | | | | | | | | | | | | | |
| Ford | Escape | Yes | SUV | 33499 | 6.6 | 7.0 | 15.2 | 14.3 | 16662.6 | $10,500.00 | $7,161.0 | -$4,665.5 | -7268.3 | 2.3 |
| Ford | Escape | No | SUV | 22999 | 10.9 | 8.6 | 9.2 | 11.6 | 23930.9 | $0.00 | $11,826.5 | | | |

## 54th Street and Franklin

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Traffic counts | | | | | | | | | |
| 1992 + 10% | | | 8 - 9 am | | Visual Survey (March 2006) | | | Car Pool | |
| Light Vehicles | | | | Walkers | Bikes | Cab w/ Fare | Bus Full | (>1 person in vehicle) | Snowmobiles |
| Thru | Right | Left | | 160 | 11 | 29 | 3 | 191 | 4 |
| 893 | 114 | 0 | | | | | | | |
| South Bound Traffic | | | | | | | | Proportion of North bound Traffic | |
| 352 | | | | | | | | 23% | |
| **Total Commuters To DT** | | | | | | | | | |
| Single vehicle | Car Pool | Walkers | Bikes | Bus | Cab w/ Fare | Estimated Total | | | |
| 817 | 382 | 160 | 11 | 135 | 29 | 1534 | | | |
| Proportion of Total | | | | | | | | | |
| 53% | 25% | 10% | 1% | 9% | 2% | | 100% | | |

## 44th Street and Franklin

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Traffic counts | | | | | | | | | |
| 2003 | | | | 8 - 9 am | 43rd and Franklin | | Car Pool | | |
| Light Vehicle Traffic | | | Walkers | Bikes | Cab w/ Fare | Bus | (>1 person in vehicle) | | |
| Thru | right | left | 39 | 2 | 7 | 1 - 1/2 full | 72 | | |
| 250 | 10 | 69 | | | | | | | |
| 44th from E - right | 44th from west - left | Franklin from S - thru | | | | | Proportion of south bound Traffic | | |
| 43 | 7 | 143 | | | | | 21% | | |
| **Total Commuters to DT** | | | | | | | | | |
| Single vehicle | Car Pool | Walkers | Bikes | Bus | Cab w/ Fare | Estimated Total | | | |
| 257 | 144 | 39 | 2 | 28 | 7 | 477 | | | |
| Proportion of Total Commuters | | | | | | | | | |
| 54% | 30% | 8% | 0% | 6% | 1% | | 100% | | |
| Mode of Transportation Into Downtown YK | | | | | | | | | |
| Single Vehicle commuter | Car Pool | Walkers | Bikes | Bus | Cab w/ Fare | Total | | | |
| 53.6% | 27.5% | 9.3% | 0.6% | 7.3% | 1.7% | 100% | | | |

## 48th Street and 49th Ave.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Traffic Counts | | | | | | | | | |
| East Bound | | | | | | | | | |
| 2003 | | 8 - 9 am | | | | | | | |
| Thru | Left | Right | | | | | | | |
| 163 | 117 | 147 | = | 427 | | | | | |
| 49th ave from N | 49th ave from S | 48th st from E | | | | | | | |
| right | right | thru | | | | | | | |
| 73 | 74 | 131 | = | 278 | | | | | |

| DOWNTOWN PARKING | Metered | | Non-Metered | |
|---|---|---|---|---|
| | Used | Not Used | Used | Not Used |
| **47th Street** | 16 | 11 | 41 | 35 |
| **48th Street** | 41 | 31 | 24 | 11 |
| **49th Street** | 50 | 45 | | |
| **50th Street** | 41 | 40 | 1 | |
| **51st Street** | 23 | 32 | 31 | 19 |
| **52nd Street** | 30 | 8 | 60 | 9 |
| **53rd Street** | 15 | 15 | 53 | 18 |
| **54th Street** | 5 | 0 | 26 | 23 |
| **49th Avenue** | 17 | 31 | | |
| **50th Avenue** | 33 | 27 | | |
| **51st Avenue** | 10 | 32 | 12 | 1 |
| **52nd Avenue** | | | 16 | 71 |
| **Total** | 281 | 272 | 264 | 187 |
| **Total Spaces (Metered vs. Non)** | Metered | 553 | Non-Metered | 451 |
| **Proportion (Used vs. Unused)** | 51% | 49% | 59% | 41% |
| **Proportion (Metered Spots vs. Non-Metered)** | Metered | 55% | Non | 45% |
| **Proportion (Used vs. Total - Metered and Non)** | Used | 51% | Used | 59% |

| | Proportion Used | Proportion Used |
|---|---|---|
| **Total** | **Metered** | **Non-Metered** |
| 103 | 59% | 54% |
| 107 | 57% | 69% |
| 95 | 53% | N/A |
| 82 | 51% | 100% |
| 105 | 42% | 62% |
| 107 | 79% | 87% |
| 101 | 50% | 75% |
| 54 | 100% | 53% |
| 48 | 35% | N/A |
| 60 | 55% | N/A |
| 55 | 24% | 92% |
| 87 | N/A | 18% |
| **1004** | | |

## A. Annual Costs

| | Registered Vehicles 2004 | Per Unit (L/yr) | Annual Cost $ |
|---|---|---|---|
| Passenger Car | 5,516 | | |
| Personal Vehicle | 5,424 | 564.1 | 612.04 |
| Taxi | 92 | 8,557 | 9283.98 |
| Passenger Van | 1,386 | | |
| Personal Vehicle | 1,380 | 802.4 | 870.58 |
| Taxi | 6 | 12,171 | 13205.63 |
| Light Utility Vehicle | 2,239 | 821.8 | 891.69 |
| Pickup Truck | 4,791 | | |
| Gas | 3,354 | 828.1 | 898.47 |
| Diesel | 1,437 | 1448.3 | 1514.64 |

## B. Commuting Cost - Downtown Yellowknife

| **Average Roundtrip Distance (km)** | **6.3** |
|---|---|

| | **Roundtrip Commuting to Downtown Yellowknife** | | | | | | | **Annual CO2 Emissions (Single Vehicle Commuters ~53.6%)** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Fuel Use (L) | | | Cost ($) | | | | | |
| | Distance (km) | Daily | Monthly | Annual | Daily | Monthly | Annual | kg/Unit/Yr | Tonne/Unit/Yr | Total Tonne/Yr |
| Passenger Car | 1634 | 0.7 | 14.1 | 169.0 | 0.71 | 15.28 | 183.38 | 415.7 | 0.4 | 1,209 |
| Passenger Van | 1634 | 0.9 | 19.8 | 237.2 | 0.99 | 21.45 | 257.35 | 583.4 | 0.6 | 432 |
| Light Utility Vehicle | 1634 | 0.9 | 20.0 | 240.3 | 1.00 | 21.73 | 260.74 | 591.1 | 0.6 | 709 |
| Pickup Truck | | | | | | | | | | |
| Gas | 1634 | 0.9 | 20.2 | 242.6 | 1.01 | 21.94 | 263.26 | 596.8 | 0.6 | 1,073 |
| Diesel | 1634 | 0.7 | 15.5 | 185.7 | 0.75 | 16.18 | 194.20 | 518.9 | 0.5 | 400 |

| | Cost ($) | | | **Annual $CO_2$ Emissions/Bus** | |
|---|---|---|---|---|---|
| | Daily | Monthly | Annual | kg/Year | Tonne/Year |
| Transit System (Adult Bus Fare) | 5 | 62 | 744.00 | 37,776 | 38 |

| GHG EMISSIONS RATIO |
|---|
| Commuter Emissions: Bus Emissions |
| 70 |

## A. Registered, Personal-Use Vehicle Fuel Consumption in YK

| | | Annual Fuel Use | $CO_2$ Emissions | | |
|---|---|---|---|---|---|
| | | Total (Personal Vehicles) | | | |
| | Registered Vehicles (2004) | (L/yr) | kg/Year | Tonne/Year | Tonne/yr/unit |
| Passenger Car | 5,516 | | | | |
| Personal Vehicle | 5,424 | 3,059,651 | 7,525,885 | 7,526 | 1.4 |
| Taxis | 92 | 787,213 | 1,936,323 | 1,936 | 21.0 |
| Passenger Van | 1,386 | | | | |
| Personal Vehicle | 1,380 | 1,107,277 | 2,723,592 | 2,724 | 2.0 |
| Taxis | 6 | 73,027 | 179,625 | 180 | 29.9 |
| Light Utility Vehicle | 2,239 | 1,840,083 | 4,526,089 | 4,526 | 2.0 |
| Pickup Truck | 4,791 | | | | |
| Gas | 3,354 | 2,777,136 | 6,830,976 | 6,831 | 2.0 |
| Diesel | 1,437 | 2,081,654 | 5,816,351 | 5,816 | 4.0 |
| | | Total (Personal Vehicles) | 29,538,841 | 29,539 | |

## B. Registered Recreational Vehicle Fuel Consumption in YK

| | | Annual Fuel Use | | | |
|---|---|---|---|---|---|
| | | Total (All register vehicles/category) | | | |
| | Registered Vehicles (2004) | (L/yr) | | | |
| All-Terrain Vehicle (ATV) | 69 | 7,667 | 18,858 | 19 | 0.3 |
| Snowmobiles (2006) | 1,839 | 551,700 | 1,357,028 | 1,357 | 0.7 |
| | | **Total (Recreational Vehicles)** | 1,375,885 | 1,376 | |

## C. City Bus Fuel Consumption

| | Units (Buses In Use) | Total City Bus Fuel Consumption (L/yr) | | | |
|---|---|---|---|---|---|
| | 6 | 81,120 | 226,657 | 227 | 37.8 |

| | | |
|---|---|---|
| **Total** | 31,141,384 | 31,141 |

## A. Registered Vehicle Fuel Consumption in YK

| | Registered Vehicles (2004) | Annual Usage km/yr | Annual Fuel Use: Per Registered Unit (L/yr) | Annual Fuel Use: Total (All register vehicles/category) (L/yr) | Annual Fuel Use: Personal Vehicles Only |
|---|---|---|---|---|---|
| Passenger Car | 5,516 | | | | |
| Personal Vehicle | 5,424 | 6,592 | 564.1 | 3,059,651 | 3,059,651 |
| Taxi | 92 | 100,000 | 8,556.7 | 787,213 | |
| Passenger Van | 1,386 | | | | |
| Personal Vehicle | 1,380 | 6,592 | 802.4 | 1,107,277 | 1,107,277 |
| Taxi | 6 | 100,000 | 12,171.1 | 73,027 | |
| Light Utility Vehicle | 2,239 | 6,592 | 821.8 | 1,840,083 | 1,840,083 |
| Pickup Truck | 4,791 | | | | |
| Gas | 3,354 | 6,592 | 828.1 | 2,777,136 | 2,777,136 |
| Diesel | 1,437 | 12,745 | 1,448.3 | 2,081,654 | 2,081,654 |

| | | |
|---|---|---|
| Person Vehicle Total (L/yr) | Gas | 9,343,514 |
| | Diesel | 2,081,654 |
| | | |
| Total (L/year) | Gas | 10,203,753 |
| | Diesel | 2,162,774 |

## B. Registered Recreational Vehicle Fuel Consumption in YK

| | | | | | |
|---|---|---|---|---|---|
| All-Terrain Vehicle (ATV) | 69 | 1,200 | 111.1 | 7,667 | 7,667 |
| Snowmobiles | 1,839 | 1,200 | 300.0 | 551,700 | 551,700 |
| | | | | **Total (L/yr)** | 559,367 |

## C. City Bus Fuel Consumption

| Units (Buses In Use) | Fuel Consumption per unit (L) - work year (260 days) | Distance Travel (km)/Year | Total Annual Fuel Consumption (L/yr) |
|---|---|---|---|
| 6 | 13520 | 36000 | 81120 |

## A. Registered Vehicles in YK

| | Registered Vehicles (2004) | FUEL EFFICIENCY CITY (km/L) | HWY (km/L) | **Average (km/L)** | CITY (L/100km) | HWY (L/100km) |
|---|---|---|---|---|---|---|
| Passenger Car | 5,516 | | | | | |
| Personal Vehicle | 5,424 | 9.7 | 14.2 | **11.7** | 10.3 | 7.1 |
| Taxi | 92 | 9.7 | 14.2 | **11.7** | 10.3 | 7.1 |
| Passenger Van | 1,386 | | | | | |
| Personal Vehicle | 1,380 | 6.9 | 9.8 | **8.2** | 14.5 | 10.2 |
| Taxi | 6 | 6.9 | 9.8 | **8.2** | 14.5 | 10.2 |
| Light Utility Vehicle | 2,239 | 6.8 | 9.5 | **8.0** | 14.7 | 10.6 |
| Pickup Truck | 4,791 | | | | | |
| Gas | 3,354 | 6.7 | 9.5 | **8.0** | 14.8 | 10.6 |
| Diesel | 1,437 | | | **8.8** | | |

## B. Registered Recreational Baseline Information

| | | | | | | |
|---|---|---|---|---|---|---|
| All-Terrain Vehicle (ATV) | 69 | 10.8 | | | 9.3 | |
| Snowmobile (as of March 2006) | 1,839 | 4.0 | | | 20.0 | |

## B. City Bus Baseline Information

| | |
|---|---|
| Passenger Capacity (Seating) | 45 |
| Passenger Capacity - (Max) | 70 |
| Fuel Mileage (Fill every 4 days) (Tank capacity - gallons) | 55 |
| Fuel Mileage (Fill every 4 days) (Tank capacity - litres) | 208 |
| Distance Travelled | 7000 - 8000km/2.5 months |
| Annual Passenger (Based on Revenue) | 133,000 |
| Daily Passengers (260 Days) | 512 |

| Units (Buses In Use) | Distance Travel km/month | Fuel Efficiency Est. (km/L) |
|---|---|---|
| 6 | 3000 | 2.7 |

| | Cost (Dollar/L) | | Vehicle Usage (km/yr) | | |
|---|---|---|---|---|---|
| Fuel Type | Self Service Filling Stations | $CO_2$ Emission (kg/L) | Personal Vehicle | Taxi | Recreational Vehicle |
| Gasoline | $1.09 | 2.460 | 6,592 | 100,000 | 1,200 |
| Diesel | $1.05 | 2.794 | 12,745 | | |

| Vehicle Type | Seated Capacity | Fuel Use L/km | Efficiency | |
|---|---|---|---|---|
| | | | L/km/ Passenger | kg $CO_2$/ Passenger/km |
| Toyota Hybrid | 4 | 0.04 | 0.011 | 0.027 |
| Mini Van (Dodge Caravan) | 6 | 0.10 | 0.017 | 0.043 |
| Large Van (Ford E-150) | 14 | 0.14 | 0.010 | 0.024 |
| Mini Bus | 20 | 0.11 | 0.006 | 0.016 |
| B-20 Biodiesel Bus | 45 | 0.32 | 0.007 | 0.020 |
| Bus | 45 | 0.38 | 0.008 | 0.023 |
| Standard Car (Gas) | 5 | 0.09 | 0.018 | 0.044 |
| Standard Truck (Gas) | 5 | 0.13 | 0.026 | 0.064 |
| Standard Truck (Diesel) | 5 | 0.11 | 0.023 | 0.064 |

# APPENDIX D

# Conversion Factors and Assumptions

**CONVERSION FACTORS**

| | |
|---|---|
| 1 gallon† = | 3.8 litres (L) |
| 1 litre (L) = | 0.22 gallons |
| 1 mile/gallon† = | 0.425 km/L |
| 10 L/100 km = | 23.5 miles/gallon† |
| 1 L gasoline = | 2.460 kg $CO_2$ |
| 1 L diesel = | 2.794 kg $CO_2$ |
| 1 tonne $CO_2$ = | 406.5 L Gasoline<br>Or<br>357.9 L Diesel |

†U. S. Gallon

**ASSUMPTIONS**

| | |
|---|---|
| Work days/year = | 260 |
| City Bus Mileage = | 7500 km/2.5 months<br>Or<br>3000 km/month |
| Average Roundtrip Commute = | 6.3 km |
| Fuel Cost = | $1.09 Gasoline<br>Or<br>$1.05 Diesel |
| Taxi Mileage = | 100,000 km/year |
| Recreational Vehicle Usage = | 1,200 km/year |
| Heavy Vehicles Mileage = | 25,000 km/year |
| Long Haul Semi Fuel Requirements = | 3,800,000 L/year |
| Winter Road Fuel Requirements = | 2,043,796 L/year |
| Daily Highway 3 Traffic = | 1,854,930 L/year (Diesel)<br>Or<br>1,517,670 L/year (Gasoline) |

# APPENDIX E

## Sample Calculations

## SAMPLE CALCULATIONS

| | |
|---|---|
| Standard Commute (Tonne $CO_2$/yr) - Passenger Car | = 6.3 km/day x 260 (work) days/year = 1,638 km/year<br>= 1,638 km/year ÷ 9.7 km/L = 169 L/year<br>= 169 L/year x 2.460 kg $CO_2$/L = 415.7 kg $CO_2$/year<br>= 415.7 kg/$CO_2$ ÷ 1000 kg/Tonne<br>= **0.4 Tonne $CO_2$/year** |
| Commute Cost (4) - Gasoline Passenger Car | = 6.3 km/day x 260 (work) days/year = 1,638 km/year<br>= 1,638 km/year ÷ 9.7 km/L = 169 L/year<br>= 169 L/year x 1.09 $/L = **184.21 $/year**<br>= 184.21 $/year ÷ 12 months/year = **15.35 $/month**<br>= 15.35 $/month ÷ 20 (work) days/month = **0.77 $/day** |
| Transit Cost ($) | = $2.50/ride<br>= $2.50 x 2/round trip = **$5/round trip**<br>= **$62/month** x 12 months/year = **$744/year** |
| City Bus Fuel Efficiency (km/L) | = 208 L ÷ 4 days = 52 L/day<br>= 52 L/day x 260 (work) day/year = 13,520 L/year<br>= 3,000 km/month x 12 month/year = 36,000 km/year<br>= 36,000 km/year ÷ 13,520 L/year = **2.7 km/L** |

| | |
|---|---|
| Annual GHG Produced by One City Bus (tonne $CO_2$/year) | = 13,520 L/year x 2.794 kg/L (diesel)<br>= 37,774.9 kg $CO_2$/year<br>= 37,774.9 kg $CO_2$/year ÷ 1000 kg/tonne<br>= **37.8 tonne $CO_2$/year** |
| $CO_2$ Emissions Ratio (Standard Commuting Car: City Bus) | = 37.8 tonne $CO_2$/year (Bus) ÷ 0.4 tonne $CO_2$/year (car)<br>= 95<br>**Emissions Ratio – 95 Commuting Car: 1 City Bus** |
| $CO_2$ Emissions Ratio (Standard Commuting SUV: City Bus) | = 37.8 tonne $CO_2$/year (Bus) ÷ 0.6 tonne $CO_2$/year (car)<br>= 63<br>**Emissions Ratio – 63 Commuting SUV: 1 City Bus** |
| Transportation Efficiency – Fuel Use/Seating Capacity City Bus (45 Seats) | = 0.38 L/km ÷ 45 passengers = 0.008<br>= 0.008 L • passenger/km x 2.794 kg $CO_2$/L<br>= **0.022 kg $CO_2$• passenger /km** |
| Hybrid Vehicle – Fuel Cost ($/km) | = 45 L/tank x 1.09 $/L (gas) = 49.05 $/tank<br>= 45 L/tank x 24 km/L = 1080 km/tank<br>= 49.05 $/tank ÷ 1080 km/tank = **0.05 $/km** |

| | |
|---|---|
| Standard Car Emissions (tonne $CO_2$ per 10,000km) | = 0.09 \$/km ÷ 1.09 \$/L (gas) = 0.08 L/km<br>= 0.08 L/km x 2.460 kg $CO_2$/L = 0.200 kg $CO_2$/km<br>= 0.200 kg $CO_2$/km x 10,000 km = 2000 kg $CO_2$<br>= 2000 kg $CO_2$ ÷ 1,000 kg/tonne = **2.0 tonne $CO_2$** |
| Hybrid Vehicle Emissions (tonne $CO_2$ per 10,000km) | = 0.05 \$/km ÷ 1.09 \$/L (gas) = 0.05 L/km<br>= 0.05 L/km x 2.460 kg $CO_2$/L = 0.123 kg $CO_2$/km<br>= 0.123 kg $CO_2$/km x 10,000 km = 1230 kg $CO_2$<br>= 1230 kg $CO_2$ ÷ 1,000 kg/tonne = **1.2 tonne $CO_2$** |