Climate Change Central

GHG Reduction in Road Transportation: A Scoping Report into Vehicle Inspection/Maintenance Programs and Alternatives in Alberta

[Draft Report]

Discussion Paper C3 - 10

October 21, 2002

Submitted By:
John Rilett

Table of Contents

List of Tables

Executive Summary

This scoping report was commissioned by Climate Change Central to research and evaluate the potential for a vehicle inspection and maintenance (I/M) program for Alberta, specifically related to reducing greenhouse gas (GHG) emissions. A secondary task was to research and highlight alternatives to I/M programs based on best practices and least-cost solutions.

Research was conducted into I/M programs across North America, with specific emphasis placed on programs in British Columbia and Ontario, Canada and Oregon, in the U.S. Operating statistics from these programs were used to estimate the staffing requirements, costs and potential GHG reductions in Alberta. Two scenarios were developed, one that required testing for all vehicles in Alberta more than two years of age, and one that focused on vehicles in urban areas. Estimates were also made based on annual and bi-annual vehicle testing. Major findings are as follows:

- Between 71 and 222 full time employment positions would be created for vehicle test technicians and management staff.
- Between 15 and 25 administration positions would be created. These positions include program managers, auditors, finance persons, engineers, analysts, automotive technicians and office administration staff.
- The average failure rate of vehicles is 13% and the average fuel efficiency improvement from emission repairs is 1.1%.
- Estimated annual costs to the public range between \$33.73 – \$105.81 million.
- The estimated annual reduction in GHG ranges between 4,016 – 12,598 tonnes CO_2e and is relatively minor in comparison to alternate options.
- The estimated cost per tonne CO_2e reduced is extremely high at \$8,399.14.

Based on the research, a vehicle I/M program does not appear to be a cost effective GHG reduction strategy.

Research was then conducted into four alternative measures to reduce GHG emission from the road transportation sector, including vehicle scrappage programs, alternative fuel vehicle programs, reducing truck speed limits to 90kmph and ethanol-blended gasoline. The first two alternatives have been run as pilot programs in Alberta. The second two alternatives were selected as they are both considered “promising measures” in the National Climate Change Program Transportation Option Paper and have been, or are being considered by the Alberta government.

Each of the four alternative options offers a greater potential to reduce GHG emissions when compared to an I/M program. The total reduction in GHG depends on the scale of the initiatives. The cost per tonne of CO_2e reduction for the four options ranges between \$50.00 and \$226.00, values that are significantly lower than the I/M program estimate.

1.0 Introduction

The purpose of this scoping paper is twofold. The first is to evaluate the potential reduction in greenhouse gas (GHG) emissions that may be achieved through a vehicle inspection and maintenance program in Alberta. The second is to highlight some alternative approaches to emission testing based on best practices and least-cost solutions.

The first part of the paper focuses on the history of emission testing, program delivery models, estimated costs and staffing requirements, and potential GHG emission reductions for Alberta. Research focused on, but was not limited to, vehicle inspection and maintenance programs in British Columbia and Ontario, Canada and the state of Oregon in the U.S.

The second part of the paper provides brief summaries of other transportation GHG reduction options that are potentially viable for Alberta. The specific measures were chosen by their existence as pilot projects in the province, or when highlighted as promising options in the National Climate Change Program Option Paper. Where possible, the GHG reduction potential is estimated, as are the costs associated with the potential reduction. In some instances, data from previous research is used to estimate these figures, while for the existing pilot projects an attempt was made to use original data from the specific project. Please note that the alternatives to emission testing highlighted in this paper are not meant to be exhaustive, but simply a selection of the more promising options.

2.0 Vehicle Emission Testing

2.1 Background on Emission Testing

Vehicle emissions are a major source of air pollution in urban centers. The combustion of fossil fuel in vehicle engines releases a number of byproducts into the atmosphere, which are detrimental to air quality. Specifically these are hydrocarbons (HC), oxides of nitrogen (NOx), volatile organic compounds (VOC's) and carbon monoxide (CO). When exposed to sunlight HC and NOx combine to create photochemical smog, while CO is a toxic gas. High levels of these substances in the atmosphere pose a significant health risk to the general public.

During the 1960s the U.S. federal government established regulations for controlling emissions from light duty vehicles (less than 6000 lbs. Gross Vehicle Weight) in order to combat declining air quality in urban centers. California was the first jurisdiction to establish emission standards due to severe air quality issues in the Los Angeles basin. Standards for HC and CO emissions were established in 1968, and upgraded in 1990 and 1996. Standards for NOx were established in 1968 and upgraded in 1977 as well as 1990 and 1996.

Canada set emission standards in 1971 that mirrored those of the U.S. This changed in 1975 when less stringent standards were imposed and remained in effect until 1988, when the Canadian standards were again raised to meet those of the United States. Standards have remained at par with the U.S. ever since.

Despite the increasing emission standards for new vehicles, there has not been an accompanying improvement in the ambient air quality in urban centers. When this discrepancy was investigated it was discovered that a significant percentage of vehicles would no longer meet the emission standards they were designed to after one to two years of use. The major causes of this phenomenon were:

1. Failure to adhere to manufacturer's recommended maintenance schedule.
2. Improper adjustment of fuel mixture, spark timing or other emission-critical engine parameters.
3. Premature failure of emission control devices or emission related devices.
4. Deliberate removal or disabling of the emission control devices installed by the manufacturer.

The concept of vehicle emission testing followed this discovery, with the goal of identifying high-emitting vehicles and requiring corrective maintenance. These programs are commonly known as Inspection and Maintenance (I/M) programs. The result expected was an overall reduction in emissions, as vehicles were returned to the emission standards for which they had been designed. The first of these programs began in New Jersey in 1974 and was followed in the 1980's in many other jurisdictions. Currently there are more than 35 vehicle testing programs operating in the U.S.

In Canada only two I/M programs are in operation. British Columbia implemented its AirCare program in 1992, and Ontario followed with its Drive Clean program in 1999. The province of Quebec is said to be considering an I/M program but has yet to implement it.

2.2 Vehicle Emission Testing and Standards

Two types of vehicle emission tests are used in nearly all jurisdictions where testing occurs. The first type is a stationary test, typically referred to as an "idle test." There are two variations of the idle test, one that simply records emission levels while the vehicle is idling, while the second measures emissions at curbside idle as well as at 2500rpm. The two-speed idle test is useful for identifying emission system problems that may not occur at curbside idle. The second type of test is completed using a dynamometer (a treadmill designed for cars), which tests the vehicle under load. These tests, while requiring more specialized equipment and time to complete, are more accurate at assessing emission levels than the non-load tests. The two most popular versions of load tests are the Acceleration Simulation Mode (ASM) test and the IM 240. Both the non-load and load tests collect tailpipe emissions with a gas analyzer that measures levels of CO, NOx, HC, carbon dioxide (CO_2) and oxygen (O_2).

Vehicle emission standards are derived from the Federal Test procedure (FTP). This is the standardized test used to ensure new vehicles will not emit more than a specified amount of a pollutant per unit of distance traveled. The pollutant limits are set by federal regulations and vary for type of vehicle and for production year. Standards for I/M testing are derived from the vehicle's original FTP standard for NOx, CO, and HCs, with an allowance based on variability in I/M test results and vehicle age. This process creates fairness in the testing, as older vehicles are tested against the standards they were designed to meet rather than standards of newer vehicles. Taking into account the allowances for vehicle age and a small variability of test results, it usually requires that a vehicle emit significantly higher than average levels of a pollutant to fail an I/M test.

Testing schedules are usually determined by the vehicle-licensing period. This means vehicles are tested every one or two years depending on the duration of the license renewal period. If a satisfactory test result is not achieved the vehicle is not re-licensed and cannot be driven legally.

If a vehicle fails an I/M test several options are available to the owner. The first is to simply retest the vehicle. A minority of failed vehicles will pass a second test due to inconsistencies in engine operation or pre-test activities, such as short warm-up periods or extreme weather. The second option is to retest the vehicle after repairs to the emission system have been made. Most failed vehicles will pass a second test with only minor repairs. The third option is a conditional pass granted upon proof of a minimum dollar value of emission repairs made by a certified repair facility.[1] This process may reduce the number of cars being retested and can simplify the process for the vehicle owner. The fourth option is a conditional pass granted after a maximum value of emission-related repairs have been carried out, even though the vehicle does not pass a second test. Typically, in this circumstance, the vehicle must pass the test at its next scheduled appointment, effectively giving the owner one or two years to make further repairs or to replace the vehicle.

It should be noted that while the above scenarios are typical of I/M programs, all jurisdictions are not uniform and many variations do exist.

2.3 Program Delivery Models

Delivery of I/M programs is similar across all jurisdictions, barring a few exceptions in organizational details. In all programs three levels of involvement exist, including administration, vehicle testing, and vehicle repair.

Administration is responsible for notification of vehicle owners about testing required, certification of testing and repair facilities, test and repair technician training, collection and analysis of test data, and inspection and auditing of test facilities. Administration is usually the responsibility of a government-affiliated body, whether municipal, state or provincial. These may include, but are not limited to, the ministry of transportation, the ministry of the environment, the department of motor vehicles, a provincial or state insurance group, or other body directly involved with motor vehicle or environmental legislation.

[1] For light duty vehicles the minimum value of emission-related repairs to acquire a conditional pass varies between $200 and $300.

Generally, vehicle testing is delivered through one of three models. One is the open market model, where independent parties may become certified to carry out emission testing as a business venture. These are typically auto repair businesses wishing to expand their services, although testing-only facilities do appear as well. Ontario's program operates in this manner. A second model of organization is a jurisdiction wide contractor-operated program. Under this model, the administrating body contracts a firm to operate test centers and the contractor assumes all equipment, land and building costs, which are recovered during the duration of the contract. British Columbia, along with some 13 U.S. jurisdictions, has chosen this option. The third model is an in-house arrangement, where the administering body also operates the test centers. The state of Oregon uses this in-house method, although a small number of independent test facilities exist as well.

I/M programs do not directly undertake vehicle repairs. However, most programs designate certified emission repair facilities. To become certified, a repair shop must have the necessary equipment and technical expertise to undertake emission related repairs. This certification of repair facilities is done largely to increase consumer confidence and to aid those whose vehicle fails an emission test to re-certify their vehicles. A conditional pass typically will be granted if a program-certified facility completes repairs of a minimum dollar value, even if the vehicle fails a retest. This eliminates the need for continuous retesting and reduces backlog at testing facilities. Repair data from certified repair facilities is usually monitored to assess type of repair made, further suggested repairs, price, and success rate if vehicles are retested.

2.4 Reporting and Administration Models

Reporting from test stations to the program administration is done online, directly from the vehicle test computer. Results from every test are downloaded to a central database controlled by the administrating body. This method eliminates the need for test stations to undertake data management or analysis tasks, thus reducing the potential for errors. Test technicians have very little control over the reporting system. For example, they cannot void a test without proper authority and subsequent explanation. This ensures that every test an individual vehicle completes or attempts is recorded to the database, making defrauding of the system extremely difficult. The result of this essentially tamper-proof reporting system is a wealth of information, down to the level of the individual vehicle, which the administrating body may use to monitor and evaluate the I/M program.

An addition to the online reporting system has been made in some jurisdictions. British Columbia's AirCare program now has an online database that tracks the repairs made to vehicles that have failed an I/M inspection. This computerized method replaces a paper and pencil form that was used previously. It is hoped that the new system will increase accuracy and participation, as it is quicker and more convenient than the paper and pencil method. Reporting repair information is voluntary and is not required as part of the program. In addition, the new system has over 90 descriptive options versus the 30 available in the past. This significantly enhances the accuracy and quality of the repair data.

2.5 Estimated Staffing Requirements For Alberta

In order to estimate staffing requirements for an I/M program in Alberta, some decisions must first be made as to the number of vehicles that will be tested annually and the frequency with which vehicles will be tested. For this paper two scenarios are considered; for quantity, all vehicles in the province vs. only vehicles in the larger urban areas.[23] For frequency, annual and bi-annual testing of vehicles are considered. The number of vehicles that require testing in a given year is based on the percentage of the Alberta vehicle fleet that is more than two years of age.[4] This standard is typical of most I/M programs.

Once the quantity is established the number of test lanes required can be estimated. The number of lanes required can fluctuate significantly depending on hours of operation and efficiency. Some test centers process in excess of 90 vehicles per day, per test lane, while other test centers are much more modest at rates of 30 to 35 vehicles. British Columbia's AirCare program was used as a model for the staffing estimates, as B.C.'s data was the most complete available. Results are displayed in Table 1 below. Based on AirCare data, it is assumed that a test lane will process an average of 82 vehicles per 8.5-hour workday and that a lane will function 345 days per year. Following the AirCare model, each test lane is operated by two technicians with a technician to management ratio of 7.4:1 for the entire system. The number of technician positions were estimated based on a 40-hour workweek and are displayed as full time equivalents.

Table 1 – Estimated Staffing Requirements For Test Centers in Alberta

	Test Frequency	**# Vehicles Tested**	**# Test Lanes Required**	**# Technician Positions**	**# Management Positions**	**Total Test Center Employment**
Province Wide	Annual	1,889,469	67	196	26	222
	Bi-annual	944,734	33	98	13	111
Urban Centers	Annual	1,204,681	43	125	17	142
	Bi-annual	602,341	21	62	9	71

As can be seen in Table 1, an I/M program in Alberta could create from 71 to 222 new jobs in operation of test facilities. In addition to these positions, a small number of administration positions would be created. Numbers from other jurisdictions vary, but it is likely that between 15 and 25 administration positions would be created. These positions include program managers, auditors, finance persons, engineers, analysts, automotive technicians and office administration staff.

---

[2] Vehicle registration totals provided by Alberta Registries – Motor Vehicles Division.
[3] Included in this estimate are vehicles registered in: Airdrie, Calgary, Cochrane, Edmonton, Fort McMurray, Grande Prairie, Lethbridge, Medicine Hat, Red Deer, Sherwood Park and St. Albert.
[4] Stastics Canada – Cansim II Table 4050044.

2.6 Estimated Costs for Alberta

I/M programs are typically designed to operate without financial assistance from government tax dollars and instead operate through funds generated from test fees. Therefore, the cost of an I/M program falls upon the vehicle owners who are required to take the test to license their vehicles. Table 2 summarizes the cost to vehicle owners in Alberta on an annual basis for the testing scenarios developed in the previous section, including an estimated cost for repairs to vehicles that fail the emissions test.

Table 2 – Estimated Annual Cost of an I/M Program

	Test Frequency	# Vehicles Tested	Test Fee	Fees Collected (millions$)	Repair Costs For Failed Vehicles (millions$)	Total Annual Cost to Public (millions$)
Province Wide	Annual	1,889,469	$ 30.00	$ 56.68	$ 49.13	$ 105.81
	Bi-annual	944,734	$ 30.00	$ 28.34	$ 24.56	$ 52.91
Urban Centers	Annual	1,204,681	$ 30.00	$ 36.14	$ 31.32	$ 67.46
	Bi-annual	602,341	$ 30.00	$ 18.07	$ 15.66	$ 33.73

The test fee of $30 was established by comparing fees from BC and Ontario ($24 and $35) respectively. Repair costs were established by multiplying the average costs of emission repairs from BC's AirCare program with an estimated failure rate based on data from B.C., Ontario and Oregon.

While Table 2 shows the total cost to the public, the program operating cost is essentially the test fees collected. These fees are divided between the test providers and the program administrators, typically with one-third of the fee going to the test provider and two-thirds going to the administration.

The test center's portion of the fee must cover the capital costs of test equipment[5], buildings and staff wages[6], with the potential for some profit. The other two-thirds of the test fee are used to cover wages for program administrators, communication with vehicle owners, certification of testing and repair facilities, test and repair technician training, collection and analysis of test data, and inspection and auditing of test facilities. These services are not intended to be for profit, as a government-affiliated body is usually responsible for their provisioning.

2.7 Estimated Greenhouse Gas Reductions From I/M

Reducing GHG emissions from automobiles has little to do with emission systems and everything to do with fuel consumption. The amount of CO_2, the most significant GHG emitted from a vehicle, is directly proportional to the amount of fuel consumed and not necessarily linked to how cleanly the fuel is being consumed. It is generally thought that

[5] Envirotest quotes a price of $50,000 to $55,000 per test lane. This cost includes necessary computers, gas analyzer, gas cap testers, dynamometer, phone lines, installation and initial staff training.

[6] Test Technician wages in BC range from $11.95 to $15.75 per hour, depending on length of employment and performance (personal communication with John Van Horne – Human Resources Manager, AirCare).

a well-tuned vehicle will improve its fuel efficiency, thus reducing the amount of fuel consumed and reducing GHG emissions. While this is true to some extent, the improvements in fuel efficiency from emission tuning are very slight. A study of some 880 vehicles, for which pre-repair and post-repair data were collected, demonstrated a mean fuel efficiency improvement of 1.102%.[7] To put this improvement into perspective, a single tire under-inflated by 6psi will increase fuel consumption by 3%.[8] Moreover, many emission repairs actually reduced fuel efficiency. In fact, any reductions in GHG emissions resulting from I/M programs are generally considered a bonus and incidental to the goals of reducing smog-creating pollutants.

Table 3 presents the estimated CO_2 reductions for Alberta based on the average 1.102% improvement in fuel efficiency from the AirCare study in BC.

Table 3 – Estimated CO_{2e} Reductions in Alberta

	Test Frequency	**# Vehicles Tested**	**Estimated Vehicle Failure (13%)**	**CO_{2e} Emissions Pre-I/M Testing (tonnes)**	**CO_{2e} Emissions Post- I/M Testing (tonnes)**	**CO_{2e} Reduction (tonnes)**
Province Wide	Annual	1,889,469	245,631	1,106,802	1,094,205	12,598
	Bi-annual	944,734	122,815	553,401	547,102	6,299
Urban Centers	Annual	1,204,681	156,609	705,671	697,639	8,032
	Bi-annual	602,341	78,304	352,836	348,820	4,016

Notes:
1. Annual kilometers estimated at 13,700km.
2. Fuel consumption pre-testing 12.3L/100km, post-testing 12.16L/100km (1.102% Improvement)

Table 4 presents the estimated cost per tonne of CO_{2e} reduction, based on the program costs from Table 2 and the estimated CO_{2e} reductions from Table 3. It is clear from the high cost per tonne of CO_{2e} reduction ($8,399.14), and the relatively small reduction quantity, that I/M testing is not a viable measure for the reduction of GHG emissions. This is largely due to the fact that approximately 13% of vehicles tested are likely to require any maintenance. The small improvement in fuel efficiency from this cohort will not significantly reduce GHG emissions for the total fleet.

[7] AirCare – Results and observations relating to the first eight years of operation (1992-2000).
[8] Auto Smart website: http://oee.nrcan.gc.ca/autosmart/howtobuy/q7.cfm

Table 4 – Estimated Cost Per Tonne CO2e Reduction

	Test Frequency	# Vehicles Tested	CO2e Reduction (tonnes)	Total Cost to Public (millions$)	Cost Per Tonne CO2e Reduction
Province Wide	Annual	1,889,469	12,598	$ 105.81	$ 8,399.14
	Bi-annual	944,734	6,299	$ 52.91	$ 8,399.14
Urban Centers	Annual	1,204,681	8,032	$ 67.46	$ 8,399.14
	Bi-annual	602,341	4,016	$ 33.73	$ 8,399.14

2.8 Benefits/Costs of Vehicle Testing in Alberta

Two benefits to I/M testing in Alberta would be the creation of jobs and an improvement in air quality through the reduction of smog-causing pollutants. However, there are several obstacles that make an I/M program impractical or problematic. First is a lack of concern about air quality, as Alberta meets and quite often exceeds federal air quality standards and is expected to in the future.[9] Second, is the likely large-scale opposition from the driving public, who will likely oppose the cost and inconvenience of an I/M program for little apparent air quality improvement. The opposition from the public will translate into a lack of political will to implement any such program as well. This is vitally important, as any benefits of an I/M program are contingent upon government regulations that ensure something is done to improve vehicles identified as high polluting. Third is the fundamental inefficiency in testing a large number of vehicles to catch a small number of high-polluters. Generally speaking, 10% of vehicles are responsible for 50% of harmful emissions.[10] A target specific method of finding high-polluting vehicles would be a better use of resources under the current circumstances, particularly when the natural renewal of the vehicle fleet will reduce smog-causing emissions through stricter vehicle production standards.

3.0 Alternative Emission Reduction Options

The following options are potential GHG-reducing initiatives that could be viable in Alberta. Due to space and time limitations, only a selected few of the possible options are included here. Some of these initiatives have already been undertaken as pilot projects in the province, or are being considered as future options. The order of presentation is random, as no one initiative is being promoted over another.

3.1 Vehicle Scrappage

The concept of a vehicle scrappage program is that an incentive is provided for owners of older, higher polluting, less efficient vehicles to turn their vehicles in for scrap recycling. Typically the incentives for such programs are rebates on the purchase of a newer, more efficient vehicle, a free transit pass and/or tax incentives for donation of the vehicle.

---

[9] Government of Alberta – Ethanol production in Alberta, April, 2000.
[10] CASA, Alberta Rover Project, Summary Report. Prepared for Clean Air Strategic Alliance, March 1999.

A pilot scrappage program, known as Breathe Easy, was operated in Calgary in 2002. The goal of the program was to remove 600 pre-1988 vehicles from Calgary roads. The vehicle owners were given a choice of either a one-year transit pass for Calgary Transit, or a $500 dollar rebate on the purchase or lease of a 1994 or newer vehicle. Originally, it was intended that a maximum of 300 transit passes and 300 newer vehicle rebates would be available. This was altered when Calgary Transit supplied an additional 50 passes, leaving the final numbers at 350 transit passes and 250 - $500 dollar rebates.[11] This program primarily focused on reducing air pollution caused by pre-1988 vehicles, as the emission standards for NOx, SOx, CO and HC were significantly improved after this model year. Little or no emphasis was placed on reduction of GHGs, such as CO_2. However, the removal of older vehicles from the road to be replaced with more efficient vehicles or transit use would have this effect as well.

Table 5 displays the funding partners for the Breathe Easy project and the support provided to date. However, the final budget from the project is not available at this time, so the following assessment of the program must only be viewed as a projection and is subject to change.[12] Support was provided either through financial contribution, or services provided in-kind (e.g. promotional material and print resources). Values for the in-kind donations have not been set for several of the participating partners.[13] It is estimated that the final cost of the program, with in-kind values included, will be $500,000, or approximately $800-900 per vehicle retired.[14]

---

[11] Personal communication with Lois Epp, Breathe Easy Co-ordinator.
[12] A final report from CASA is expected in early 2003.
[13] Project partners: Alberta Environment, Alberta Motor Association, Alberta Registry Agents Association, Calgary Motor Dealers Association, Calgary Community Lottery Board, Calgary Pick Your Part, Calgary Transit, Canadian Petroleum Products Institute, Clean Air Strategic Alliance, Climate Change Central, Environment Canada, The Kidney Foundation, Transport Canada's Moving on Sustainable Transportation Program.
[14] Personal communication with Kieth Denman, CASA Breathe Easy Co-ordinator.

Table 5 – Breathe Easy Program Funding (Preliminary Estimates)

Financial Funding Sources	**Pledged Funding**	**Utilized**
Environment Canada	$ 120,000.00	$ 50,000.00
Transport Canada – MOST	$ 25,000.00	$ 25,000.00
Canadian Petroleum Products Institute	$ 25,000.00	$ 25,000.00
Climate Change Central	$ 60,000.00	$ 50,000.00
Clean Air Strategic Alliance	$ 4,000.00	$ 4,000.00
Calgary Community Lottery Board	$ 5,000.00	$ 5,000.00
Sub Total	**$ 239,000.00**	**$ 159,000.00**
In-Kind Donation Sources		
Calgary Transit	Annual Transit Passes ($660)	$ 231,000.00
Calgary Motor Dealers Association	Vehicle Rebates ($165)	$ 41,250.00
The Kidney Foundation	Tax Credits ($50)	$ 30,000.00
Calgary Pick Your Part	Emission Testing & Vehicle Decommissioning	Not Valued
Alberta Motor Association	Printing & Communication Services	Not Valued
Alberta Registry Agents Association	Vehicle Information	Not Valued
Sub Total		$ 302,250.00
Total Costs (Less services not yet valued)		**$ 461,250.00**

The evaluation of the Breathe Easy program in terms of its effectiveness as a GHG reduction program is also problematic at this time. To date, only half of the approved vehicle rebates have been utilized, leaving the data on replacement vehicles incomplete. This information is required to properly assess the program, as the fuel efficiency of the replacement vehicles will alter the GHG reduction potential. For example, a large number of SUV's or trucks would reduce the average fuel efficiency, in turn limiting GHG reductions (e.g. 14.2L/100km for SUVs vs.10.14L/100km cars).[15] Statistical data from Transport Canada on average driving distances and fuel consumption in Alberta was used to calculate several scenarios of potential GHG reductions. These scenarios are displayed in Table 6.

[15] Transport Canada – Transportation in Canada 2001 Annual Report.

Table 6 – Vehicle Replacement C0₂ Reduction Scenarios

# Transit Passes	# Vehicles	Type of Vehicle	CO_{2e} Reduction (Tonnes)	Scenario Comparison	Cost per Tonne CO_{2e}	Cost per Tonne CO_{2e} (Cash Investment)
350	250	6 - 9 years old (11.3L/100km)	2,211	61%	$ 226.14	$ 71.91
350	250	0 - 5 years old (10.8L/100km)	2,274	63%	$ 219.85	$ 69.91
350	250	High efficiency (7L/100km)	2,754	76%	$ 181.53	$ 57.73
350	250	Electric Hybrid (4.5L/100km)	3,070	84%	$ 162.85	$ 51.79
600	0	Transit Only	3,639	100%	$ 137.41	$ 43.70

Notes:
1. Annual vehicle kilometers estimated at 18,900.
2. CO_{2e} calculated at 2.674kg per litre of gasoline.
3. Assumes participants choosing the transit pass do not own or purchase another vehicle.
4. Assumes no additional transit service would be required to handle increased volume.
5. Cost per tonne calculated assuming $500,000 budget to operate program.
6. Cost per tonne (cash investment) based on $159,000 investment to date.

Of the five scenarios included in Table 6, the first one is likely the most accurate estimate of results from the Breathe Easy program. This is due to the program parameters that stipulate replacement vehicles are to be 1994 models or newer, thus the 11.3L/100km is the best fit to represent the replacement fleet. The last two scenarios were included to show the best-case scenario of a vehicle scrappage program, although they are unlikely solutions for the near future.

It should be noted that the estimated cost of CO_{2e} reduction in Table 6 is for one year only. The cost per tonne of CO_{2e} reduction is significantly reduced if the investment is spread over what would have been the natural lifetime of the scrapped vehicles. Table 7 illustrates the declining costs over a four-year period.

Table 7 – Cost Per Tonne CO_{2e} Reduction Over Vehicle Natural Life

Vehicle Life Shortened By	Cost per Tonne CO_{2e}	Cost per Tonne CO_{2e} (Cash Investment)
1 Year	$ 226.14	$ 71.91
2 Years	$ 113.07	$ 35.96
3 Years	$ 75.38	$ 23.97
4 Years	$ 56.53	$ 17.98

Notes:
1. Based on scenario 1 from Table 2

The sooner a vehicle is retired the more cost effective a scrappage program will be in terms of reducing GHG emissions. If one assumes that the average vehicle is retired three or more years before its natural life expectancy, the cost per tonne of CO_{2e} reduction becomes competitive with other initiatives considered "promising" in the National Climate Change Process (NCCP) Transportation Option Paper.

The vehicle scrappage program run under the Breathe Easy model could be a viable GHG reduction strategy for the following reasons:

1. The program is a cost-effective measure to reduce GHG emissions, assuming that the vehicle life is reduced by two or more years. Under these circumstances vehicle scrappage becomes competitive with other initiatives identified as "promising" in the NCCP Transportation Option Paper.
2. The program was well received by the public, indicating a continued interest in participation.
3. Project partners received positive media attention, which enhanced their public image and encouraged participation.
4. The program improves ambient air quality by reducing pollutants other than GHG, increasing the general appeal.

Several issues could significantly alter the effectiveness and viability of a scrappage program, including the following:

1. Transit passes are the single largest cost of operating a scrappage program under the Breathe Easy model. If these are not donated by the transit provider and must be purchased at face value, the program would likely become financially unviable without significant government funding.
2. In order to be effective at reducing GHG emissions, an incentive to purchase more fuel-efficient vehicles should be included. This could take on the form of a larger rebate for more efficient vehicles, or eliminating the rebate for vehicles that have a fuel consumption rating above a certain limit (e.g. > 10L/100km).
3. If the program is to include rural areas, the absence of transit services reduces the appeal of the program and reduces the GHG reduction potential.

3.2 Alternative Fuel Vehicles

Vehicles designed to run on alternative fuels to gasoline or diesel can provide significant GHG emission reductions. Currently, the most practical replacement fuels are compressed natural gas (CNG) or propane. Recently natural gas has become the preferred alternative because the propane supply has been erratic and I/M programs have found propane is more polluting than gasoline.[16]

CNG can provide a 26% reduction in GHG emissions over gasoline in a light duty vehicle and a 10% reduction in a city bus when compared to diesel. So far, CNG has proved ineffective for heavy-duty trucks owing to the lack of space for fuel tanks on the vehicles, which severely limits range between refueling.

[16] Levelton Engineering Ltd. *Transportation & Climate Change: Alternative fuels market research study. Prepared for Transportation Issue Table. National Climate Change Process,* June 1999.

In 2001, Climate Change Central and ATCO Gas entered a partnership with seven tour operators in the town of Banff to convert tour vehicles, predominately one-ton passenger vans and shuttle buses, to operate on CNG. This program, known as eMissions Banff, was designed to reduce GHG emissions and improve air quality in the Banff-Calgary corridor and in the Banff townsite. The Town of Banff also agreed to convert diesel transit buses to CNG as part of the program. Financial incentives were provided to tour operators by Natural Resources Canada and Climate Change Central to reduce the capital costs of either converting vehicles or purchasing new CNG vehicles. Table 9 summarizes the funding structure for CNG vehicles.

Table 8 – Vehicle Conversion Funding

Funding Source	**Vehicle Conversion**	**New Vehicle Purchase**
Natural Resources Canada	$500	$2,000
Climate Change Central	$1,000	$2,000
Operator	$4,500	$4,000
Total Vehicle Premium	$6,000	$8,000

The installation of a natural gas fueling station in the town of Banff was a significant part of the program. This is the first natural gas station to be located in Banff, as well as the first ever in a national park. ATCO Gas was responsible for all logistical operations concerning the station and assumed the majority of the construction costs. The station is open to the public as well as project partners. Table 10 summarizes the preliminary project budget for both the vehicle and station capital costs. Unfortunately, the final project budget is not available at this time.

Table 9 – eMissions Banff Capital Funding Budget (All numbers preliminary)

Funding Partners	**Vehicle Premium**	**Fueling Station**	**Total Capital Investment**
Climate Change Central	$90,000	-	$90,000
ATCO GAS	-	$246,500	$246,500
Natural Resources Canada	$85,500	$12,500	$98,000
Operators	$259,000	-	$259,000
Totals	**$434,500**	**$259,000**	**$693,500**

To date, over 60 vehicles have been converted as part of the program, resulting in an estimated 1000 tonnes greenhouse gas equivalent (GHGe) reduction each year at a cost of approximately $50 per tonne.[17]

Assuming the final budget for the eMissions Banff project is not significantly different from the projected budget, it appears that this type of program is a cost effective way to limit GHG emissions. The major obstacle to this type of program is the lack of natural gas refueling stations in the province. Currently, only 13 stations exist throughout the

[17] Climate Change Central – Due Diligence Summary – eMissions Banff.

province, including stations in Edmonton, Red Deer, Calgary and Lethbridge. In order to significantly increase the number of natural gas vehicles in the province the refueling infrastructure would need to be expanded, or emphasis placed on fleet vehicles that operate solely in the areas already serviced with natural gas stations. In the latter case, the refueling capacity would likely need to be increased if the number of natural gas vehicles increased significantly.

One area for expansion of the eMissions Banff project would be the Banff-Jasper and Edmonton-Jasper corridors. The installation of a refueling site in Jasper would improve the network infrastructure and allow tour operators in the Jasper area to emulate their Banff counterparts.

3.3 Reducing Truck Speed Limit to 90 kmph

The trucking industry in Canada accounted for 22.9% of vehicle fuel used, while only accounting for 7.8% of the total vehicle kilometers in 2000. The average fuel efficiency for tractor-trailers is 43.14L/100km and 34.79L/100km for straight trucks. The trucking industry is expected to expand continuously over the next 20 years, thus increasing the total fuel consumption and in turn the volume of GHG emitted.[18] All these factors have led to research into improving the fuel efficiency of the trucking industry.

Reducing highway truck speeds is one way of increasing fuel efficiency and reducing the volume of GHG emitted. A truck traveling at 90kmph uses approximately 7% less fuel than one traveling between 90 and 110kmph. A further 8% is gained over a truck traveling between 110 and 130kmph. In Alberta, reducing the truck speed limit from the current 100-110kmph on highways would translate into a fuel savings of 3.8L/100km.[19] Table 8 demonstrates the fuel savings and subsequent reduction in GHG emissions possible from reducing truck speed limits in Alberta.

Table 10 – Estimated Reduction in GHG with Truck Limit of 90kmph

Annual Truck km (millions)	% km >90kmph	Truck km >90kmph	Fuel Savings Per 100km	Litres of Fuel Saved (millions)	Reduction in CO_2e (tonnes)
4920.7	54%	2657.178	3.8L	100.97	279088.72

A reduction of approximately 279,000 tonnes of CO_2e per annum would be significant to the province of Alberta and would correspond to approximately $58.6 million in fuel cost

[18] Transport Canada – Transportation in Canada 2001 Annual Report.
[19] Taylor, G; Nix, F; and Delaquis, M. *The Potential for GHG Reductions from Improved Use of Existing and New Truck Technology in the Trucking Industry, Prepared for National Climate Change Program – Transportation Table Trucking Sub-Group,* April 1999.

savings to truck operators.[20] It is estimated that the increased cost of labour would be greater than the fuel savings, resulting in a cost of $47.00 per tonne CO_2e reduced.[21]

The Alberta Ministry of Transportation has expressed an interest in reducing truck speed limits as a GHG reduction strategy. However, there are several obstacles that need to be addressed before implementing any new speed limits.

The first obstacle is the safety concern of having a dual speed limit (e.g. 90kmph for trucks and 100-110kmph for cars), as the risks of this speed differential are not well known. Jurisdictions in both the U.S. and Europe do operate with such a system, but any increased risk of accident is not well documented. The feeling in Alberta is that if road safety were compromised, a dual speed limit would not be approved regardless of the potential GHG benefits.

The second obstacle is the potential cost to the economy in Alberta by slowing down the movement of goods. The major concern is that a relative decline in driver productivity would lead to an increase in labour costs for transportation services. Opposition is likely to arise from drivers who are paid by distance covered and trucking firms concerned about rising labour costs. A better understanding of the potential costs to Alberta would be useful in finding potential solutions to cost increases, or changing negative misperceptions about reducing truck speeds.

A third issue is enforcement of a lower speed limit. Lowering the posted speed limit will only create the desired fuel savings if it is enforced sufficiently. More information is required concerning the costs of enforcement, including the necessary staffing, equipment, administration and time in the judiciary system for processing of fines.

Technology is available to have trucks limit their own speed through the use of electronic engines, thus removing the need for roadside enforcement. Electronic engines can be set to control the maximum speed of the truck, essentially removing control from the driver. Unfortunately, this system is rather problematic, as limiting the maximum speed of the Alberta registered trucking fleet may give an unfair advantage to trucks based in other jurisdictions. Any apparent loss of competitiveness would create severe opposition from the trucking industry and likely limit the chances of implementing a speed reduction program.

Despite the concerns mentioned above, the concept of reducing the truck speed limit does hold a good deal of promise as a GHG reduction strategy. Further research into the costs and benefits of such a program would be recommended.

[20] Based on a diesel fuel valued at $0.58 per litre.
[21] Taylor, G; Nix, F; and Delaquis, M. *The Potential for GHG Reductions from Improved Use of Existing and New Truck Technology in the Trucking Industry, Prepared for National Climate Change Program – Transportation Table Trucking Sub-Group,* April 1999.

3.4 Ethanol Fuel Blending

The increased use of ethanol-blended fuel could reduce Alberta GHG emissions from transportation. Ethanol, usually derived from wheat or corn, is a renewable fuel source that is believed to have significantly lower GHG emissions over its lifecycle than gasoline. Blending a small amount of ethanol with gasoline aids in the complete combustion of fuel in vehicle motors and has been shown to increase fuel efficiency. It is estimated that a 10% ethanol blend in gasoline (E10) would result in a 3.5 to 4.6% reduction in GHG from vehicles in Alberta.[22] Based on gasoline sales in Alberta for 2001[23] this would equate to a CO_2e reduction of approximately 434,000 to 571,000 tonnes per annum. The cost per tonne of CO_2e reduction ranges from $52 to $93 depending on the source material of ethanol and the production process used.[24]

The Alberta government has already undertaken a comprehensive study of ethanol production and potential.[25] The findings of this study estimate that the use of a 10% ethanol blend in gasoline would reduce GHG emissions from vehicles and would provide a net economic increase of $104 to $132 million/year in the province through increased employment and growth of the feedlot industry. A by-product of ethanol production from wheat is wheat gluten, which is sold as feed for livestock.

Despite the apparent benefits of increased ethanol use, several issues stand in the way of implementing an ethanol program. The first and most significant is controversy surrounding the amount of energy required to produce ethanol. Currently ethanol has a higher input to output energy ratio when compared to gasoline. Higher energy consumption in the production process essentially equates to increased GHG emissions during the production process. Therefore, the potential GHG reductions quoted above may not be realized unless more energy efficient production methods are used. One potential solution is a new process developed by IOGEN Corporation that uses biomass, such as straw or grass, to make ethanol. It is estimated that this process could more than double any GHG reductions achieved by using wheat or corn as an ethanol feedstock.[26]

A second issue is that the majority of oil refiners do not see ethanol as economical. Currently ethanol is more costly than gasoline on an equivalent volume basis. Therefore, it is unlikely that oil refiners will choose to blend ethanol unless mandated to, or unless they are offered financial concessions to make the costs equal to that of straight gasoline. The exception in Alberta is Husky Oil, which has blended ethanol with gasoline for many years. Further research into why Husky Oil has made this decision would be beneficial to developing an ethanol policy in Alberta.

Third, is the issue of current ethanol production capacity in Alberta. The only producer of ethanol in the province is API Grain Processing, located in Red Deer. API has an annual

[22] Government of Alberta – Ethanol production in Alberta, April 2000.
[23] Statistics Canada – Cansim II Table 4050003.
[24] Transportation Climate Change Table, *Transportation and Climate Change: Options for Action: Options Paper for the Transportation Climate Change Table*, National Climate Change Secretariat, November 1999
[25] Government of Alberta – Ethanol production in Alberta, April 2000.
[26] Personal communication with Maurice Hladik, IOGEN Corporation.

production capacity of 22 million litres. In order to achieve a 10% ethanol blend in all gasoline, over 400 million litres/year of production capacity would have to be constructed. This is assuming that ethanol is not purchased from producers outside the province. In order to develop this new capacity a guaranteed market and/or financial incentives would be required to ensure profit on investment in the ethanol industry. Under current market conditions the majority of the ethanol produced in Alberta is exported to the U.S. market.

Fourth, is the sentiment expressed by the Alberta government that it is premature to determine ethanol's priority as a GHG-reduction option. This is largely due to the uncertainty of GHG benefits and potential conflict with the petroleum industry. Without Alberta's commitment to increasing the use of ethanol through mandated blending or financial incentives, it is unlikely that any significant change will occur.

In order for ethanol-blended gasoline to become a viable GHG reduction strategy in Alberta, the four issues discussed above would need to be addressed. The most crucial of these is the government support of ethanol initiatives and the exploration of new production technologies that will achieve greater GHG reductions than traditional methods.

4.0 Conclusions

The purpose of this report was twofold. The first was to evaluate vehicle inspection and maintenance programs in terms of their effectiveness as GHG reduction strategies. The second was to highlight alternative approaches to reduce GHG emissions from the road transportation sector.

Research suggests that vehicle inspection and maintenance programs are not a cost-effective measure to reduce GHG emissions. Vehicle testing programs are designed to improve the ambient air quality by ensuring that vehicles meet specific standards for emissions of smog and ground level ozone creating substances. Vehicle fuel efficiency is not of concern to an I/M program, which is what a true GHG reduction program must be focused on. While the proper emissions tuning of vehicles does have a small positive impact on fuel efficiency, these gains are incidental and not significant. In light of the lack of air quality concerns in Alberta and the high cost of operating a vehicle I/M program, implementing a program would be an inefficient use of resources.

The second part of the report highlighted four alternatives to reducing GHG emissions from road transportation. These were vehicle scrappage, alternative fuel vehicles, 90kmph truck speed limits and 10% ethanol blended gasoline. The first two options have been successful pilot projects in Alberta. At the present time the final reports from the organizing bodies of these projects are not available, however, the analysis of the preliminary data shows that these initiatives are cost effective measures to reducing GHG emission. Further expansion of these projects would be advisable assuming the final results confirm their viability.

The second two options, reducing truck speed limits and ethanol-blended gasoline, were selected as they are both listed as “promising measures” in the NCCP Transportation Option Paper and have been, or are being considered by the Alberta government. The analysis of these options is essentially limited to estimates of GHG reduction potential, due to the fact that most data available is on a national, not provincial level. These options have some significant challenges to implementation. However, the GHG reduction potential from both options suggests that further investigation into alleviating these challenges would be warranted.

References

AirCare, *Results and observations relating to the first eight years of operation (1992-2000)*, 2001. As found online at: www.aircare.ca.

CASA, *Alberta Rover Project, Summary Report. Prepared for Clean Air Strategic Alliance,* March 1999.

Government of Alberta, *Ethanol production in Alberta – Final Report. Prepared for Interdepartmental Ethanol Committee, Government of Alberta,* April 2000.

Levelton Engineering Ltd. *Alternative and Future Fuels and Energy Sources for Road Vehicles. Prepared for Transportation Issue Table. National Climate Change Process,* July 1999.

Levelton Engineering Ltd. *Transportation & Climate Change: Alternative fuels market research study. Prepared for Transportation Issue Table. National Climate Change Process,* June 1999.

L-P Tardif & Associates Inc. *Environmental awareness and outreach measures to reduce GHG emissions from the trucking sector. Prepared for National Climate Change Program – Transportation Table Trucking Sub-Group,* May 1999.

Taylor, G; Nix, F; and Delaquis, M. *The Potential for GHG Reductions from Improved Use of Existing and New Truck Technology in the Trucking Industry, Prepared for National Climate Change Program – Transportation Table Trucking Sub-Group,* April 1999.

Transportation Climate Change Table, *Transportation and Climate Change: Options for Action: Options Paper for the Transportation Climate Change Table*, National Climate Change Secretariat, November 1999.