Clean Air Research Fund

Status Report - 2004

Clean Air Research Fund Steering Committee

April 2005

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1. Introduction

Since the inception of the BC Clean Air Research (CAR) Fund at the end of 1995, the fund has been utilized for two programs, BC Scrap-It and Clean Air Research. From the outset half of the fund has been used to start the BC Scrap-It pilot program for retirement of old high-polluting motor vehicles. Since 1997 contributions have been made from the fund to a number of research projects on air quality in the Lower Fraser Valley and other areas of the province. The *"Clean Air Research Fund Status Report - 1997-1999"*, July 2000, and subsequent annual reports provided summaries of the activities supported by the fund from the beginning to the end of the year 2003. This report summarizes the projects funded from the CAR Fund in the year 2004. It also provides brief descriptions and the status of the BC Scrap-It program and various research proposals considered for funding during this period.

All Clean Air Research Fund Status Reports are currently being made available at the following web site of the B. C. Ministry of Water, Land and Air Protection: http://wlapwww.gov.bc.ca/air/airquality/carf/index.html

2. Clean Air Research Fund History

In December 1995, the Canadian Petroleum Products Institute (CPPI) and BC Ministry of Water, Lands and Air protection (WLAP, formerly Ministry of Environment, Lands and Parks), signed an agreement on CPPI funding for two specific programs. While the BC Scrap-It Program is an old, high-polluting motor vehicle scrapping program, the Clean Air Research Program is for research projects on air quality issues in the Province with a particular focus on transportation and fuels. Under the agreement, CPPI is committed to contribute up to a maximum of $500,000 per year for a total of $2.5 million over the 5-year period (1996-2001), and the total annual amount is to be split between the two programs. The agreement was amended in December 1997 to include the Greater Vancouver Regional District (GVRD) as another party to the agreement. The CPPI funding members are Chevron Canada, Husky Oil, Imperial Oil, Petro-Canada and Shell Canada. Unless otherwise agreed by the Parties, $250,000 per year will be dedicated to support clean air research on air quality issues during the 1997-2001 period. The Clean Air Research Fund (CARF) is being managed by a Steering Committee consisting of one representative from each of CPPI, WLAP and GVRD.

As the original CARF was due to expire at the end of 2001, the Parties agreed in March 2001, to continue the Agreement until *"... the full commitment of $2.5 million has been expended or committed."* Hence the Fund is still used for air quality research projects and the BC Scrap-It Program beyond the year 2001.

The CARF Steering Committee usually meets 3 or 4 times a year. Environment Canada and the Fraser Valley Regional District representatives attend the meetings as observers.

3. Clean Air Research Fund Program Achievements in 2004

As in previous years, the CAR Fund was used to support both the BC Scrap-It Program and a number of research projects in 2004. The achievements of these financial contributions are described in the following sections.

3.1 BC Scrap-It Program

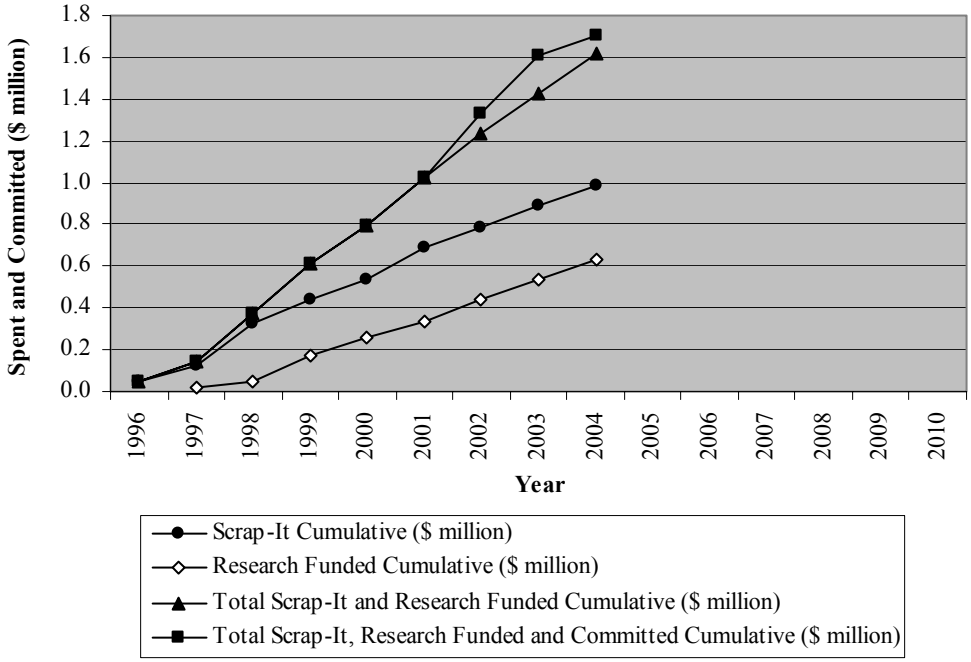
The BC Scrap-It Program was launched as a pilot project for retirement of old high-emitting vehicles in 1996 by WLAP in the Lower Mainland and Victoria. The program partners included the CPPI, BC Hydro, Vancouver and Victoria Regional Transit Commissions and BC Automotive Dealers Association (BCADA). WLAP, GVRD, and AirCare provided additional in-kind support to the program. The pilot program was operated from April 1996 to November 1998, and 955 vehicles of 1983 or older high-polluting vehicles were scrapped.

Based on the experience of the pilot program, in November 1998 the Scrap-It program was expanded to the owners of 1987 or older vehicles. Since 1999 the program has been funded by the CPPI, Translink, Insurance Corporation of B. C. and the BCADA. WLAP, GVRD, and AirCare (now Pacific Vehicle Testing Technologies) have continued their support for the program. Environment Canada supported the program with an annual contribution of $60,000 in fiscal years 2001-2002 and 2002-2003. Another Scrap-It type program is also operating in Kelowna, B. C. with funding from Environment Canada.

Presently, the Scrap-It Program Steering Committee is investigating the creation of a charitable society to manage the program; draft bylaws have been approved, and it is anticipated that the move to a society model will occur in 2005.

The CPPI contributions to the Scrap-It program are illustrated in Figure 1. A total of $100,000 was paid towards the program in the year 2004, which brought the total CPPI contributions to the Scrap-It since 1996 to $988,550.

Figure 1. Clean Air Research Fund Status



The choice of incentives for the vehicle owners participating in the program has also been widened in subsequent years. The incentives presently offered to vehicle owners include: (i) varying amounts of cash toward the purchase of a new natural gas vehicle, a new vehicle, used 1994 or later model year vehicle, (ii) bicycle, (iii) money towards vanpooling or carpooling, and (iv) a choice of transit or West Coast Express pass.

Nearly 2,010 vehicles were scrapped between November 26, 1998 and December 31, 2003. In the year 2004 a total of 591 vehicles were approved for scrapping and 461 vehicles were scrapped. The vehicle owners opted for a total of 430 incentives: 206 transit passes, 10 West Coast Express passes, and cash for 181 new and used less-polluting vehicles, 32 bicycles, and 1 vanpool.

The major benefits accrued from the Scrap-It program have been a cost-effective reduction in vehicular emissions and an increased public awareness about alternatives to the use of old high-polluting vehicles. The estimated reductions in emissions of hydrocarbons (HC), nitrogen oxides (NO_x), carbon monoxide (CO) and carbon dioxide (CO_2) from recycling of vehicles for which incentives were granted during the pilot and expanded phases of the program are provided below. These estimates are based on the methodology developed in the August 1997 study, *"Evaluation of the Scrap-It Pilot Program"*, one of the projects funded from CAR Fund.

Estimated Emission Reduction Benefits of the Scrap-It Program

Program Phase	**Reduction in Contaminant and Greenhouse Gas Emission, tonnes**			
	HC	**NO_x**	**CO**	**CO_2**
Pilot	164	43	1,173	7,691
November '96 - December '02	276	75	2,231	14,418
January '02 – December '03	53	14	393	3,077
January '04 – December '04	82	22	579	4,113

Note: Assuming 13,010 km/yr distance driven for 3 years, the remaining life of the scrapped vehicle.

Source: CAR Fund Status Report – Year 2001, January 2003, January 2004, and Scrap-It Program Administration Office, February, 2005.

On the basis of the pilot program evaluation, the Scrap-It program has been found to be cost-effective, about $2, 177 per tonne of 'emission' reduced. The 'emission' in this context refers to the contaminants with smog-forming potential, and calculated as ($HC + NO_x + CO/7$). The cost-effectiveness of greenhouse gas reduction was estimated to be $130/t of CO_2, indicating that the program is not currently cost-effective when considered only in terms of these gases.

3.2 Clean Air Research Fund Contributions

In the year 2004, about $90,560 was paid from the CAR Fund towards the completed and on-going projects. This amounted to nearly $650,590 contributions from the CAR Fund to various projects and the fees paid to the CAR Fund coordinator during 1997-2004. In 2004 an amount of $12,500 was also contributed towards Bob Caton Memorial Scholarship Fund. The funding committed, but remains to be paid, towards the remaining on-going projects by the end of 2004 amounts to about $69,833. The estimated total value of all projects co-

funded from the CAR Fund is approximately $11.2 million. The major projects towards which partial CAR funding have been made include:

(i) Ethanol BC (Total - $7.4 million and CAR funding - $100,000),
(ii) Pacific 2001 (Total - $1.4 million and CAR funding for 2 projects - $62,584), and
(iii) Canadian Synthetic Diesel Fuel Testing (Total - $1.25 million and CAR funding - $60,000).

The total value of all other projects is estimated to be about $1.7 million, and the contributions, already made and committed, from the CARF to these projects amount to $493,149 or 29%. The history of the CAR Fund contributions made and committed to date towards all research projects which are complete and in-progress till the end of 2004 is shown graphically in Figure 1.

3.3 Clean Air Research Program Achievement

Proposals submitted to the Steering Committee for CAR funding are required to meet the following eligibility criteria:

(1) research projects should be on air quality issues relevant in B. C. and in particular on issues related to transportation and fuels;
(2) in general, funds will not be available solely for capital equipment purchases, on-going programs or staff salaries and benefits;
(3) generally the funding will be limited to a maximum of one-third of the total project cost, with an annual maximum of $50,000 or 20% of the fund for any single project;
(4) payments will be made either in installments according to approved project deliverables or in full upon project completion and acceptance of the final report.

Typically no projects will be funded in advance, and all three Steering Committee members must approve a project. Preference will be given to projects of immediate priority and to those co-funded by other partners.

Five new proposals for financial support from the CAR Fund were received in 2004, bringing the total proposals received since 1997 to 61. Eight projects were completed in 2004, and the total number of projects completed during 1997 – 2004 was 27. The categories of projects completed until the end of 2004 are listed in Table 1. It should be noted that as some projects were jointly sponsored or undertaken by more than one proponent, the total number of completed projects categorized in Table 1is more than the number mentioned above. The completed projects along with their key findings are described in Section 3.4.

By the year-end, out of 5 new and revised proposals considered during the year, the funding has been approved for two and the projects are in-progress. The other three proposals have been approved-in-principle and still remain under consideration for funding. Another proposal received in 2003 was deferred in 2004. At the end of the year, nine projects are in-progress. The projects in-progress, new proposals under consideration, and the proposal deferred in 2004 are summarized in Tables 2 and 3 respectively, and described briefly in Section 4.

Table 1: Projects Completed in 2004
(Completed projects during 1997-2003 in parenthesis)

Project Proponent	Project Type				
	Basic Research	**Applied Research (Study & Assessment)**	**Planning**	**Pilot Demonstration Program**	**Other**
University - Academic	(4)	(1)			
- Student		1	(3)		
Business and Industry		1 (4)		1	
Government agencies		4 (9)	1 (2)		(1*)
Non-governmental Organizations					

* Training session on a new model (MOBILE 6) for estimation of on-road motor vehicle emission factors.

TABLE 2: Clean Air Research Fund

Research Projects - In-Progress at the end of 2004

Project/Proposal Title	Project Proponent/ Sponsor	CARF Steering Committee Contact	Project Application Date and Schedule			Project Funding ($)					Project Progress Status		Comments
			Application Date	Project Start Date	Project Completion Date	Total Proposed	CAR Funding Requested, Approved and Paid			Other Partner Funding			
							Requested	Approved	Paid	Partner Fund ($)	Interim Report	Final Report	
Projects Approved and In-progress at the end of 2004													
1 Ethanol BC - Process Development Program	The University of B. C.	BC WLAP	March 1999	March 2000	March 2005	$7.4 million over 5 yrs.	$100,000 at $20,000/year for 5 years.	$20,000/yr for 5 yrs.	$100,000 paid during 2000-2004.	Various amounts from federal and provincial governments and several private sectors.	Quarterly progress reports during the past 5 years.		Capital cost is $2.5 million, and operating cost is $4.9 million. The project Steering Committee has to date approved about $500,000 for several projects. At the request of the CARF Steering Committee the proponent submitted a summary of the 5-year progress report on the project in August 2004.
2 Canadian Synthetic Diesel Fuel Testing Project - Phase 4	CPPI	CPPI	December 2003	some time in 2004	see comments.	$400,000 - $500,000 per fiscal year	$15,000	$15,000	$15,000 in Dec. '04.	The remainder in cash and in-kind from various partners.	Quarterly progress reports.		This project is a continuation of the multi-partner funded project on the testing of emissions from synthetic diesel fuel burning. Phases 1, 2 and 3 partially funded from the CARF are complete.
3 Emissions Reduction Options Study for HDV/Fleet in the LFV	GVRD	GVRD	April 2003	June 2003	December 2003/January 2004. (see comments)	$149,000	$54,000	$54,000	$49,500 were paid during Nov. 2003 - July 2004.	GVRD - $32,000, Env. Can. - $24,000, WLAP - $15,000, each of GVTA, FVRD and Clean Energy - $5,000. (see comments)	Quarterly progress reports.		Contract awarded to Levelton Engrg. and others on June 27, 2003. The project scope was later expanded with an increased budget, and the CARF share is now $54,000. The final report is expected in the 1st Quarter 2005.
4 Application of Automated Correlation-based Synoptic Map Classification for Establishing a Climatological Link with Air Quality Episodes in Prince George, British Columbia	Paul F. Willis	WLAP	January 2003	see comments.	July 2004	$4,558 (not including tution fees and other costs)	$4,558	Upto a max. of $6,000.			Quarterly progress reports.		The proposal is for doing research for a M.Sc. degree at the UNBC. A detailed proposal was submitted in July 2003 and approved for funding in August 2003. The thesis defence is scheduled for March 2005.
5 Testing of Continuous Water Injection System on one of the two Main Engines onboard the MV Queen of New Westminister	BC Ferry Services Inc.	Env. Can.	June 2003	November 2003	By March 2004	$55,500	One-third of the total cost.	$18,500	$7,525 was paid in March 2004.	$18,500 - Env. Can. and BC Ferries - $18,500	Quarterly progress reports.		This is the second phase of a test project completed in 2002 on an auxilliary engine on the BC Ferry *Queen of New Westminster* . The 12-month testing period was completed in December 2004. The final report is due shortly.
6 ISOPART Model Application to the LFV	S. Pryor, Indiana University	CPPI	February 2003	3rd Quarter 2004	12-month project	$84,809	Approx. one-third of the total cost.	$30,000		WLAP - $15,000, Env. Can. - $25,000, FVRD - $10,000 and GVRD - $5,000.	Quarterly progress reports.		A revised proposal with a new budget was submitted in February 2003. CARF funding of one-third of the total budget has been approved. The work started in the 3rd Qtr. 2004 for a 12-month project.
7 Reduction of Nonroad Diesel Emissions in the Province of B. C..	Genesis Enginnering	GVRD	Nov. 2003	Upon funding approval.	8 months from start date.	$25,000 increased to $40,000.	$18,000 increased to $23,000.	$6,000 increased to $13,300.	$7,500 paid in July and Nov. '04.	GVRD - $17,000, WLAP - $7,000.	Quarterly progress reports.		The project started in January 2004. The draft report was submitted in June 2004. Additional work for an extra cost of $15,000 was approved in November 2004. The final report is due early 2005.
8 FIX-IT Program 2nd Pilot Project	PVTT (AirCare)	CPPI	March 2004	May 2004	6 months from start date.	$46,000	$16,000	$16,000		PVTT - $30,000 (in-kind)	Quarterly progress reports.		The project started in May 2004. It is now on hold due to lack of response from vehicle owners.
9 Data Collection for Non-Certified Emission Repairs	PVTT (AirCare)	CPPI	October 2004	November 2004	6 months from start date.	$19,000	$6,000	$6,000		PVTT - $6,800 (in-kind), Envirotest Canada - $6,200 (in-kind)	Quarterly progress reports.		The project started in November 2004, and due for completion by April 2005.

TABLE 3: Clean Air Research Fund

Research Proposals - Remaining as Approved-in-Principle and Deferred at the end of 2004

Project/Proposal Title	Project Proponent/ Sponsor	CARF Steering Committee Contact	Project Application Date and Schedule			Project Funding ($)					Comments
			Application Date	Project Start Date	Project Completion Date	Total Proposed	CAR Funding Requested and Approved			Other Potential Partner Funding	
							Requested	Approved	Paid		
Proposals Remaining as Approved-in-Principle at the end of 2004											
1 High Resolution Meteorological Fields over BC for Air Quality Applications	UNBC	WLAP	June 2004	upon approval of funding	3-year project from start date	$225,000 for 3 years - $75,000 per year	$75,000 for 3 years - $25,000 per year				A revised proposal was submitted in June 2004 at the suggestion of the Steering Committee. The proposal merits, scope and funding are still being considered prior to approval. CPPI's approval of any funding would depend upon an agrred upon approach to the project.
2 Updating the Lower Fraser Valley Source-Receptor Air Quality Model	RWDI West Inc	GVRD	June 2004 Revised in Dec. 2004	see comments.	6-8 months from start date.	$39,410-$64,780 + GST. See comments.	$47,670 (all of Ph.1 & 2). See comments.			WLAP, GVRD, Env. Can.and B. C. Lung Assoc. - to be confirmed.	Dec. 2004 revised proposal is for Ph. 1 ($39,410), Ph. 2 ($8,260) and 2 optional tasks worth $17,110. All fundings are to be confirmed.
3 2005 B. C. Marine Vessel Emission Inventory	GVRD	GVRD	October 2004	early 2005. see comments.	some time in 2006.	approx. $120,000	Part of the total.			GVRD, WLAP, Env. Can., Transp. Can., Western Marine Community, Ports and other industry assoc.	The proprosal is for a 2-Phase work for developing improved methodology and 2005 inventory and forecasts. CPPI would be interested in partial funding for a nationally acceptable model/methodology development study that would have application in other areas of Canada.

3.4 Projects Completed in 2004

1. *.Marine Vessels Air Emissions in the Georgia Coast Cascade Air basin and Coastal Areas for the Year 2000*

   The Greater Vancouver Regional District (GVRD) retained Levelton Engineering Ltd. to prepare an emission inventory of marine vessels for the Georgia Coast Cascade Air Basin for the year 2000, and to do forecasts of emissions from marine vessels in the Air Basin to the year 2025. The project was a multi-partner effort at a total cost of $94,000, and the funding from CARF was $13,600.

   The 3-Phase project was initiated in October 2001 starting with Phase 1 (marine vessels emission inventory for the Core Area [GVRD and Fraser Valley Regional District] for 2000) and Phase 2 (marine vessels emission inventory for the Expanded Area [B. C. outside LFV and Washington Coast, including Whatcom County and Puget Sound] for 2000). The Phase 3 work consists of backcasts and forecasts of marine vessels emissions for both Core and Expanded Areas. The year 2000 emission inventory is used as the baseline for backcasting emission estimates to 1985 and forecasting future emissions to the year 2025.

2. *Vehicle Emissions Inspections and Maintenance – Effects on CO_2 Emissions and Fuel Consumption*

   Pacific Vehicle Testing Technologies Ltd. (PVTT), administrator of the AirCare Program, completed this project in 2003 with funding from Environment Canada. The CAR funding of about $3,530 was used for presentation of the study findings at the 14th CRC On-Road Emissions Workshop held in March 2004 in San Diego, California and to publish the results in the May 2004 issue of the Journal of the Air and Waste Management Association. The project developed a methodology to project full-duration fuel consumption and carbon dioxide emission from IM240 tests conducted during AirCare inspection.

3. *"Canadian Synthetic Diesel Fuel Testing Project – Phase 3"*

   This is a multi-million dollar phased project on the Canadian Synthetic Diesel Fuel Testing.sponsored by several partners such as National Research Council, Syncrude, CPPI, Shell, Suncor, Imperial Oil, Environment Canada, Natural Resources Canada and US Dept. of Energy. The budget for the Phase 3 work was $490,000 of which $15,000 was contributed from CAR fund.

   The National Research Council of Canada, Ottawa has been the prime contractor for the project. The Phase 3 work started in the 4th Quarter of 2002 and was completed at the end of 2003. This phase of the work investigated the effects of fuel origin, exhaust gas recirculation (EGR), fuel sulphur content and cetane improver on different pollutant emissions from the Caterpillar single cylinder 2004 model year engine. EGR was found to be effective in reducing the composite NO_x emissions; however, it led to an increase in PM emissions. The fuel quality seems to have to sensitivity to PM emission increase. An increase in the fuel sulphur content showed an increase in PM emissions. It has also been determined that the PM emission increase is affected by the total sulphur content and not by the type of sulphur compounds in the fuel.

4. *"FIX-IT Program Pilot Project 1"*

Pacific Vehicle Testing Technologies Ltd. (PVTT), administrator of the AirCare Program, conducted the project at a total cost of $76,000. The contribution from CAR fund was $16,000 and the rest was borne by PVTT in cash and knid.

The goal of the project is to develop a new initiative to reduce vehicle exhaust emissions of pre-1992 light-duty vehicles. A working model of the proposed FIX-IT program has been designed, and the objective of this project is to evaluate the operational procedures and potential benefits of the FIX-IT program. A total of 15 vehicles, of an average age of vehicles of 17 years and with an average odometer reading of 231,000 km, were assessed for repair effectiveness from before- and after-repair mass emission testing. The vehicles were repaired at certified repair shops, and the repair costs ranged from $334 to $1,342 with an average cost of about $800. It has been determined that repair shops with good track records can be relied upon to perform good diagnoses and repairs, and the emissions from even old, high mileage vehicles can be brought back into compliance with original emission standards. The cost-effectiveness of repair was estimated to be: $390/tonne of CO, $1,141/tonne of HC and $1,259/tonne of NO_x. However, the public response and participation in the study was found to be slow.

5. *"Ambient and Personal Exposure Levels of Fine Particulate Matter ($PM_{2.5}$) Throughout the Prince George Airshed"*

The project was undertaken by a graduate student from the Faculty of Natural Resources and Environmental Studies, University of Northern B. C., as her thesis research work. The total budget for the work was $55,000 from several government and private agencies, and the CAR funding amounted to $10,000.

The objective of the project was to develop a detailed understanding of the relationship between ambient $PM_{2.5}$ concentrations and actual personal exposure levels and to determine the spatial variation of these parameters within the Prince George airshed during a 6-week period in the winter of 2001. Personal exposures of 15 children and ambient levels on their respective school roofs were collected, and $PM_{2.5}$ mass, sulphate and absorption coefficient (as a surrogate for elemental carbon) were measured in both samples. The total $PM_{2.5}$ personal exposure was contributed almost equally by ambient and non-ambient sources, and a strong association between ambient concentration and ambient generated exposure was found. The final thesis was successfully defended in May 2004.

6. *"Tunnel Study Pacific 2001 – Effects of Fuel and Lubricant Quality on Vehicle Emissions. Fuel Analysis."*

Environment Canada was the leader and sponsor of this project, which was a part of the Pacific 2001 intensive air quality monitoring program during August-September 2001 in the Lower Fraser Valley. The objective of the project was to characterize gasoline and diesel fuels and lubricants used in vehicles, as well as to assess their potential impacts on motor vehicle emissions during the Cassiar Tunnel Testing during August 9-15, 2001. The project was a collaborative work undertaken by Environment Canada, CPPI, GVRD, AirCare and other partners.

The total budget for the Pacific 2001 project was approximately $1.4 million. The

CAR funding of about $12,570 was provided for the sampling and analysis of fuels and lubricants done by the CPPI and Alberta Research Council.

Field experiments, collection of fuel samples, and extensive sampling and monitoring of various contaminants and gases emitted from motor vehicles were done during the Pacific 2001 monitoring period in August-September 2001. Samples were collected during 20 sampling intervals to capture emissions from vehicles traveling through the Cassiar Tunnel in Burnaby, B. C. during weekdays and weekends. Samples of road dusts from the tunnel were also collected and analyzed. The fleet characterization information from AirCare and ICBC was used to estimate vehicle emission rates. The gaseous and PM samples collected were analyzed for a wide-range of chemical species. Fleet average profiles of particle phase organic compounds were derived from source apportionment studies. Various data were used to estimate emission factors for light-duty and heavy-duty vehicles. In general, the estimated emission factors are consistent with those obtained in other tunnel studies in the U. S. A. and Europe, with the exception of the CO_2emission factors which were unusually low for some unknown reasons. Various aspects of the study are to be published in the scientific literature.

7. *"M. A. Turbo – Water Injection Emission Reduction System (testing at US Navy)"*

Environment Canada sponsored the project on behalf of M. A. Turbo/Engine Ltd. to test the effectiveness of water injection in marine vessel diesel engines in reducing nitrogen oxides emission. An amount of $3,500 was contributed from the CAR fund towards the total project cost of $18,700.

M. A. Turbo/Engine Ltd. conducted tests with its water injection system at the US Navy engine testing facility in Philadelphia. The regular base fuel and biofuel were tested in an engine, and reductions in NOx emissions by as much as 22% due to water injection were observed at a wide range of engine power. There were significant reductions in emission of total hydrocarbons for all range of engine operations; however, there was no effect of water injection on specific fuel consumption.

8. *"Vehicle Emissions Inspection and Maintenance – Effects on CO_2 Emissions and Fuel Consumption – Phase 2."*

In continuation of the earlier phase of the project, described above as project 2, the University of B. C. led this phase of the project. The goal of the project was to develop a statistical model, using the test data from the first phase of the work, to project full-duration fuel consumption rate and CO_2 emission from IM240 tests for vehicles which are fast-passed as early as 30 seconds from starting the test. Another part of the project was to test the model with other test data not used to develop the model.

The total budget for the project was $12,000 and the CAR funding was $4,000.

A statistical analysis of over 3044 records of IM240 inspection test data from November 2002 – May 2003 and November 2003 was used to find a prediction algorithm. After removing 14 outliers, the final model was developed by using 2038 test records, and it was tested by using a separate set of 992 test records. The model is an improved one for projecting full-duration carbon emissions and fuel consumption from a fast-pass test. The original Phase 1 method was found to be accurate to within 12% 9 times out of 10 for fast-pass after 30 seconds. The new model has reduced this error to less than 8%. It also uses additional information which is already available within each inspection record.

4. Status of CAR Funded Projects and Proposals until the end of 2004

Summaries of the year-end 2004 status of the projects in progress and proposals under consideration are provided below. One proposal submitted in 2003 was requested to be deferred by the proponent in 2004 is also described.

4.1 Projects In-progress at the end of 2004

1. "Ethanol BC"

Project Lead/Sponsor
The University of British Columbia (UBC) leads this multi-stakeholder sponsored project under a stakeholder Steering Committee. WLAP is CAR Fund Steering Committee Contact.

Project Goal and Objectives
The primary goals of the project are to promote development and demonstration of technologies for production of ethanol, electricity and other products from softwood residues, and a commercial ethanol facility in B. C. by the year 2005. The ethanol project has three major objectives – process development demonstration, development of policy recommendations and preparation of a business plan for commercialization of the process.

Project Funding
CAR Fund –$100,000 over a 5-year period with an annual contribution of $20,000 since the year 2000. Other Partners – Province of B. C. - $300,000, and various amounts of cash and in-kind contributions from Federal Government Agencies, UBC and the private sector. Currently, Ethanol BC relies primarily on finding provided by the provincial beehive burner fee rebate program from the forest products industry. The revenue available from this source in 2004 is estimated to be $414,000. The last installment of $20,000 from CARF was paid on November 30, 2004. Total estimated cost - $7.4 million for the 5-year project duration. CARF commitment for $100,000 has been met. The Steering Committee will have to decide if the project funding will be extended for future project work.

Contractor
UBC Faculty of Forestry is the primary contractor. Several sub-contractors are also to be retained for ancillary work.

Approval Date
The project was approved by the Steering Committee in July 1999.

Completion Date and Status
This is a 5-year project consisting of several components. The work on the Ethanol Process Development Unit (PDU) at UBC Faculty of Forestry is continuing. Some success has been reported in the selection of yeast for conversion of glucose sugar to ethanol. In addition, funds have been approved by the Ethanol BC Steering Committee to the following companies.

Nexterra (formerly EthoPower) is presently continuing test programs of characterization of syngas generated from woodwaste at its newly built Kamloops R & D facility. It has completed its emission testing program and found an average uncontrolled emission of 20 mg/m^3, and it expects to reduce particulates emission to rival that from natural gas burning. The company is also investigating application of its technology to a pulp mill lime kiln. Nexterra is preparing a project proposal for using the syngas for lumber dry kilns and log conditioning vats for a BC Interior plywood mill. This project will be supported by a $75,000 grant from Ethanol BC.

Lignol Innovations are continuing trial testing of their lignin as well as from softwood residue as a substitute for phenol formaldehyde. Ethanol BC has recently approved a further funding of $75,000 subject to approval of a minimum of $150,000 from NRCan. However, the company's future is dependent on raising the necessary venture capital of $2.5-3.0 million, which is the requirement for receiving a grant of $1.6 million from Sustainable Technology Development Canada.

A grant of $30,000 was approved by Ethanol BC to Entropic Power for demonstration of its Turbion power technology for small-scale power generation (<1 MW) at BC Hydro's PowerTech research facility. However, subsequently as BC Hydro has withdrawn its support for the research project, Ethanol BC's approval of the grant is being withheld until entire funding for the project is secured.

Pinnacle Pellet received $15,000 funding from Ethanol BC to investigate market and technology development for production of wood bark pellets from sawmill wood residues at its plants in Quesnel and Williams Lake. The study is currently underway, and there is a potential for shipping 400,000 tonnes of wood pellets to Europe.

Any further CARF involvement in the project would be decided after receiving a final report to be requested from the project Steering Committee.

2 .Canadian Synthetic Diesel Fuel Testing Project – Phase 4

Project Lead/Sponsor
CPPI is both the sponsor of this proposal and CAR Fund Steering Committee Contact.

Project Goal and Objectives
The Phase 4 of the project is a continuation of the Phases 1, 2 and 3 of the Canadian Synthetic Diesel Fuel Testing Project. The plans for this phase of the project include: (i) to perform data mining study to assess the fuel quality and emissions data collected during past years, and to collect additional data, if necessary, (ii) to measure nitrous oxide emissions from Caterpillar 3401E engine operating under various levels of exhaust gas recirculation, (iii) and to study the effects of hydrotreater/hydrocracker processing severity on engine emissions.

Project Funding
A total of $400,000 -$500,000 has been budgeted for Phase 4 work, and the CAR Fund contribution would be $15,000. Besides the CARF contribution, the remainder was being provided in cash and in-kind by other project partners (National Research Council, Syncrude, CPPI, Shell, Suncor, Imperial Oil, Environment Canada, Natural Resources Canada and US Dept. of Energy).

Contractor
National Research Council of Canada, Ottawa.

Approval Date
Project was approved by the Steering Committee in the first Quarter of 2004.

Completion Date and Status
The project started in the 1st Quarter of 2004, and it is scheduled for completion by the end of 2004. The National Research Council (NRC) has installed a N_2O analyzer to measure emissions during various tests. Four very low sulphur fuels have been tested, and fuel samples have been sent to Shell Canada for analysis. A set of experiments with biodiesel derived from different sources is planned. The Canadian Diesel Fuel Research Collaboration (CDFRC) Project Study is initiating a research project with Oak Ridge National Laboratory to test synthetic diesel fuels in a light-duty diesel engine. The NRC is also looking for an expert for the data mining study.

3. *"Emissions Reduction Options Study for Heavy-Duty Vehicles/Fleet in the Lower Fraser Valley"*

Project Lead/Sponsor
Greater Vancouver Regional District is both the sponsor and the CAR Fund Steering Committee Contact.

Project Goal and Objectives
The project goal is to promote social, environmental and economic sustainability in the Lower Mainland region of B. C.. The primary objectives of the study are to provide guidance to the GVRD, its member municipalities, the Greater Vancouver Transportation Authority and others on the options to reduce emissions from their existing heavy-duty diesel vehicles and future purchases of vehicles and engines and fuels.

Project Funding
Because of the expanded scope of the project the total cost has increased to $149,000. An additional CAR funding of $8,500 has been approved for a total contribution of $49,500. Other contributors to date are: Environment Canada - $24,000, WLAP - $15,000, and FVRD, GVTA and Clean Energy - $15,000 ($5,000 each), and GVRD - $32,000. The GVRD is anticipated to make up the budget short-fall.

Contractor
Levelton Engineering Ltd. and Others.

Approval Date
The project was approved by the Steering Committee in April 2003.

Completion Date and Status
The contract for the study was awarded and the work started in the last week of June, 2003. The scope of work was finalized following the contract award, and additional tasks, at a cost of about $24,340, were identified and approved to improve the study results. After some delay due to ICBC data procurement, the study was completed during the 2nd Quarter 2004. A draft report was submitted to the project technical committee for comments, and on June 30, 2004 the consultant made a presentation on the study findings to the committee. The draft report was revised in September incorporating all technical and editorial comments from the reviewers, and a proposal was submitted for addressing additional items at an extra cost, which were considered to be beyond the scope of the original contract. This proposal was approved in the 4th

Quarter 2004. The final report is due in January 2005, and it will include a disclaimer from CPPI regarding the scientific basis for the health effects equation used by the consultants. (CPPI has retained an epidemiologist to review this particular aspect of the study and the review will be included as an appendix in the report.)

4. *"Application of Automated Correlation-based Synoptic Map Classification for Establishing a Climatological Link with Air Quality Episodes in Prince George, British Columbia"*

Project Lead/Sponsor
Paul F. Willis is the sponsor of this proposal with his advisor Dr. Peter Jackson of the Faculty of Natural Resources and Environmental Studies, University of Northern B. C.. WLAP is the CAR Fund Steering Committee Contact.

Project Goal and Objectives
The objective of the project is to develop a recurring and representative map pattern of circulation associated with meteorology favourable to air quality in Prince George. This will include the stages of the development, beginning and decay of any air pollution episode. The research will be the basis of the thesis for a M. Sc. Degree in Environmental Studies at the University of Northern B. C..

Project Funding
The revised project budget is estimated to be $7,070 of which $4,558.00 is requested from the CAR Fund.

Contractor
Not applicable.

Approval Date
After considering a revised proposal submitted at the request of the Steering Committee, a funding of a maximum of $6,000 was approved by the Steering Committee in August 2003.

Completion Date and Status
The pilot study was completed in September 2003. A new computing environment including a new computer and FORTRAN programs has been developed for data analysis. Tests have been done and verified against manual calculations. Further work is being done to establish an efficient computing environment. The data analysis programs are complete and ready for final runs. The second draft of Chapter 1 of the thesis is complete for review by thesis supervisor. The draft of Chapter 2 is complete, and analysis of data is being performed. The present schedule for completing the thesis is March 2005.

5. *"Testing of Continuous Water Injection System on one of the two Main Engines on board the MV Queen of New Westminster"*

Project Lead/Sponsor
BC Ferry Services Inc. is the sponsor, and Environment Canada on behalf of CAR Fund Steering Committee is the Contact.

Project Goal and Objectives
The primary objective of the project is to test the effectiveness of water injection in reducing nitrogen oxides emission from one of the two main diesel engines onboard

the MV Queen of New Westminster of the BC Ferry Services Inc.. This is the Phase 2 of an earlier project completed in 2002.

Project Funding
Total budget is $53,500 of which $18,500 is to be contributed from the CAR Fund. Other funding partners are Environment Canada - $18,500 and BC Ferry Services Inc. - $18,500.

Contractor
M. A. Turbo/Engine Ltd..

Approval Date
The project was approved by the Steering Committee in July 2003, and the final agreement between the contractor and BC Ferry Services Inc. was signed in November 2003.

Completion Date and Status
The project started in December 2003. The baseline measurements of two of the No. 2 main engine cylinders were taken and the continuous water injection (CWI) system was installed during the first month. The CWI system was fully operational by the end of January 2004. After the initial test phase, inspection of the main engine cylinders revealed some water accumulation during the period when the CWI system was not operating. An auxiliary diesel generator, also equipped with the CWI system, showed some plugging of air cooler with deposits. As a result, several modifications were made to the water injection system before it was used again. Because of the above delay it has been decided to extend the test period until November 2004 to collect sufficient operational data for a proper comprehensive assessment of the CWI system effectiveness in reducing NO_x emission and fuel consumption. Altogether 4,826 hours of operation with water injection has been completed. The results show that with water injection NO_x emissions were reduced between 21 and 25%, CO emission was reduced by up to 5% and fuel consumption was improved by 1.7%. No excessive engine cylinder wear was observed with water injection, and both scavenging air and exhaust gas temperatures were also reduced with water injection. Overall, it is estimated that the payback period of a water injection system for the Queen of New Westminster's all four main engines would be less than 1.5 years.

An initial payment of $7,000 from the CARF approved amount of $18,500 was made in March 2004. The remaining $11,500 will be paid upon project completion and submission of the final report.

6. *"ISOPART Model Application to the LFV"*

Project Lead/Sponsor
Ms. S. Pryor of Indiana University is the sponsor, and CPPI is the CAR Fund Steering Committee is the Contact.

Project Goal and Objectives
The project is a follow-up of an earlier study, partially funded by CAR, on the application of ISOPART air quality trajectory model undertaken during Pacific 2001 intensive study in Lower Fraser Valley of B. C.. The primary objectives of the present project are to run a modified ISOPART model using output from meteorological model simulations for receptors in three regions within the LFV. The results will be

presented for each of the four seasons as a chemical/air quality climatology for these regions and chemical sensitivities to sea spray and ammonia burdens.

Project Funding
Total budget is $84,809 of which $30,000 is to be contributed from the CAR Fund. Other funding partners are Environment Canada - $25,000 and WLAP - $15,000, FVRD - $10,000 and GVRD - $5,000. Due to the current favourable dollar exchange rate, the total cost and CARF's share will be expected to be less at the end of the project.

Contractor
Ms. S. Pryor, Indiana University.

Approval Date
The project was approved by the CARF Steering Committee in November 2003, and other partner contributions were confirmed soon afterwards.

Completion Date and Status
The project started in the 3rd Quarter of 2004 for completion by December 2005. To date the ISOPART model has been revised to enable it to run using meteorological data to be supplied by University of B. C. and to provide improved treatment of the partitioning of acid gases. Ten representative, 3-day simulations have been selected and meteorological data are used to compute back-trajectories from the 3 receptor locations at 3-hour intervals. The receptor locations have been identified to provide geographical diversity as well as to match the Pacific 2001 sampling locations. Emission files for each period have been requested from the UBC. It is anticipated that emissions data will be extracted and processed by the end of March 2005, and actual modelling will commence shortly after that.

7. *"Reduction of Nonroad Diesel Emissions in the Province of B. C."*

Project Lead/Sponsor
The Greater Vancouver Regional District (GVRD) is the sponsor and CARF contact.

Project Goal and Objectives
The primary objectives of the project are to identify cost-effective methods by using clean fuels and technological solutions and estimated reductions in reducing smog-forming emissions from nonroad diesel engine emissions in the GVRD, Lower Fraser Valley (LFV) and the rest of the Province of B. C..

Project Funding
Total budget has been increased from $25,000 to $40,000, and accordingly the CARF contribution is now increased to $13,300 from $6,000. Other funding partners are GVRD - $17,000 and WLAP - $7,000. The remaining $27,000 funding is yet to be confirmed.

Contractor
Genesis Engineering Inc. is the consultant for the study.

Approval Date
The project was approved by the CARF Steering Committee in December 2003; and other partner contributions were confirmed soon afterwards.

Completion Date and Status
The contract was awarded in February 2004 and started immediately. It is anticipated to be completed in 8 months. There was a delay in obtaining detailed data for the LFV nonroad equipment inventory as GVRD was updating its data for the year 2000. In August 2004 the reviewers' comments on the draft report submitted in June 2004 were received. In order to address several comments, additional work beyond the scope of the original contract has been performed at an extra cost. Models have been developed and tested to address various comments made on the draft report. A revised draft report is expected in the 1st Quarter of 2005.

8. *"FIX-IT Program 2nd Pilot Project."*

Project Lead/Sponsor
Pacific Vehicle Testing Technologies (PVTT) is the sponsor/leader of the project, and CPPI is CAR Fund Steering Committee Contact.

Project Goal and Objectives
The goal of the project is to continue development and verification of the model developed during the 1st pilot program. The model will be refined to determine potential effectiveness and administrative process that can be implemented to provide repair cost assistance for vehicles which would otherwise use the cost waiver and conditional pass provisions of the AirCare program.

Project Funding
CAR Fund –$16,000 approved in May 2004.
PVTT is to contribute the remainder (about $30,000) as in-kind contribution.
Total - $46,000 in cash and in-kind.

Contractor
PVTT (AirCare Program Administration).

Approval Date
A revised proposal incorporating certain requirements of the CARF Steering Committee was approved in May 2004.

Completion Date and Status
The project was started in May 2004 and anticipated to be complete in six months. Ten AirCare-certified repair shops have been selected and solicited for their participation in the project. These shops consist of the seven which had participated in the first pilot program plus three additional shops in N. Vancouver and Abbotsford to improve geographic coverage. The project objectives, guidelines and vehicle eligibility criteria have been discussed with each participating repair shop. The total number of participating repair shops has been limited to ten because it is anticipated that about 20 vehicles will be targeted in the study. Various means of active promotion of the project have been implemented to seek response and participation by vehicle owners. However, because of poor response, the promotion of the project is currently suspended until further notice, and CARF is in agreement with the decision.

9. *"Data Collection for Non-certified Emission Repairs."*

Project Lead/Sponsor
Pacific Vehicle Testing Technologies (PVTT) is the sponsor/leader of the project and submitted the proposal in October 2004. CPPI is the CAR Fund Steering Committee Contact.

Project Goal and Objectives
More than half of vehicles failing the AirCare emission inspection are performed by non-certified repair shops. No data on the types of repair done and costs are available. The goal of the project is to collect repair information from a sample of these vehicles by offering a small incentive ($2) to vehicle owners. The information will then be analyzed to determine the cost-effectiveness of non-certified emission-related repairs.

Project Funding
CAR Fund –$6,000 approved in May 2004.
PVTT and Envirotest Canada are to contribute $6,800 and $6,200 as in-kind contribution respectively.
Total - $19,000 in cash and in-kind.

Contractor
PVTT (AirCare Program Administration).

Approval Date
The proposal was approved by the CARF Steering Committee for funding of $6,000 in the 4th Quarter 2004, although an incentive of $2 was considered to be too small.

Completion Date and Status
The project was started in December 2004 for an anticipated completion by April 2005. The first run of 6,000 flyers is being prepared for distribution to vehicle owners in early January 2005.

4.2 New and Revised Proposals Approved-in-Principle by the end of 2004

By the year end three proposals received between June and December 2004 remain as approved-in-principle for CAR funding. These proposals are listed in Table 3, and briefly described below.

(i) "High Resolution Meteorological Fields over BC for Air Quality Applications"

The original proposal submitted in March 2004 by Prof. P. L. Jackson, University of Northern BC (UNBC) was considered by the Steering Committee and the members had sought several clarifications. In June 2004 the revised proposal was submitted to the Committee. It is proposed to use mesoscale models to produce and validate a 5-year high resolution dataset of meteorological fields over BC and to render these fields available for air quality modelling applications. It is a 3-year project to be conducted under supervision of Prof. Jackson by a research associate or post-doctoral fellow and research assistants. The CAR fund requested is $25,000 per year for 3 years, and the total budget is estimated to be $225,000 ($75,000/year). The remainder of the budget is to be covered by grants and potential funding from other agencies. The proposal is presently being considered by the Committee.

(ii) "Updating the Lower Fraser Valley Source-Receptor Air Quality Model."

RWDI West Inc. had first submitted the proposal in March 2003 for CAR funding, and it was approved-in-principle. Because of the project leader's sudden death, the Committee requested RWDI West Inc. about its interest in pursuing the project under a new leader and project team, as well as to resubmit it for consideration. The revised proposal for updating an existing air quality model was submitted in June 2004, and after further revisions it was submitted in December 2004. The current proposal is for a 2-Phase project with 2 optional tasks. The total budget varies from $39,410 to $64,780 (plus GST), depending on the Phases and optional tasks. The funding of $47,670 (plus GST) for the Phases 1 & 2 is requested from CARF. The Committee is presently considering the proposal.

(iii) "2005 B. C. Marine Vessel Emission Inventory"

The GVRD submitted the proposal in October 2004 to undertake a 2-Phase work for a 2005 marine vessel emission inventory and forecasts for the Lower Fraser Valley at an estimated cost of about $120,000. The project is planned to be conducted jointly with Env. Can., Transport Canada, WLAP, Western Marine Community, Ports, and other industry sectors. A partial funding from CARF is requested. As the 2000 inventory for the marine vessel emission and emissions forecasts have recently been completed, CPPI has some concern about the new project. However, after receiving clarification about the objectives of the new project, i.e. to enhance the methodology and data collection, CPPI has advised it might be interested in partial funding for a nationally acceptable model/methodology development study for application in other areas of the country. CPPI believes the BC CARF funding level should be in line with that of the marine industry so the total industry CARF level could approach the one-third funding level. The Committee intends to consider the proposal at its next meeting in early 2005.

4.3 Proposal Deferred in 2004

"Mapping Roles and Responsibilities for Energy and Greenhouse Gas Management in Greater Vancouver.

In November 2003 the Greater Vancouver Regional District (GVRD) submitted the draft Terms of Reference (ToR) for the proposed study to be undertaken by consultants. As there were a few comments on the draft ToR from the Committee members, the proposal was approved-in-principle for CAR funding of one-third of the total budget of $20,000, subject to revision of the draft ToR as suggested by the members.

5. Future Outlook of CAR Fund

Under the Scrap-It program nearly 3,000 old vehicles have been scrapped during the period March 1996 to December 2004, and the CPPI contribution to the program to December 2004 has been about $988,550. The present resources allow scrapping of about 500 vehicles per year. Although the number of scrapped vehicles is relatively low, compared to the total number of vehicles used in the region, the cumulative effect of retirement of high-polluting old vehicles over the years has resulted in cost-effective incremental emission reduction in the Lower Fraser Valley. The participation in the Scrap-It program appears to depend on the types of incentives available to the owners of old vehicles and the level of public awareness. Adequate funding for attractive incentives to vehicle owners' participation is also a key to the

success of the Scrap-It program. Presently, The Scrap-It Program Steering Committee is exploring the possibility of creating a charitable society to manage the program.

A similar Scrap-It type program is also operating in Kelowna, B. C. with funding from Environment Canada.

From August 1997 to the end of 2004 nearly $600,000 from the CAR Fund has been contributed towards a number of research projects. By the end of 2004, a total of about $69,850 from the CAR Fund remains committed towards projects that are still in-progress. The total value of all these projects, jointly funded from the Clean Air Research Fund and various other partners, amounts to about $11.95 million.

The projects funded to date consisted of basic and applied research, including pilot demonstration of technology, collection of information for planning purposes, and training program for agency personnel, industry and consultants. The study proponents ranged from academic and students to industry and government agencies. The type of projects included:

- analysis of air quality, emissions and meteorological data,
- air quality model development,
- enhancement of emission estimation methods,
- computer model development for greenhouse gas emission assessment,
- projects to improve AirCare testing and vehicle repair diagnosis,
- transportation demand management, and
- training of personnel from agencies, industry and consultants.

Research projects undertaken with full or partial CAR funding have resulted in significant scientific advances through improved understanding of key air quality issues, filling of important data gaps, and development of modeling tools to better forecast impacts of emission reduction measures on future air quality. Continued financial support from the CAR Fund for research on air quality issues will lead to improved understanding of the science, and development or enhancement of models and tools for data gathering and analysis. These are necessary prerequisites for formulation of appropriate air quality management strategies and policies.