ROADSIDE OPTICAL VEHICLE EMISSIONS REPORTER (ROVER) III

Project Report for the CASA Board

CASA

SEPTEMBER 2024

About the Clean Air Strategic Alliance

CASA is a multi-stakeholder partnership. It is composed of representatives selected by industry, government, non-government organizations, and participating First Nations and Métis communities to provide strategies to assess and improve air quality for Albertans, using a collaborative consensus process. Every partner is committed to a comprehensive air quality management system for Alberta.

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Acronyms

AAAQO	Alberta Ambient Air Quality Objective
AMTA	Alberta Motor Transport Association
AMVIR	Access to Motor Vehicle Information Regulation
AQMS	Air Quality Management System
AT & EC	Alberta Transportation and Economic Corridors
CAAQS	Canadian Ambient Air Quality Standards
CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
CMAQ	Community Multiscale Air Quality (model)
CO_2	Carbon dioxide
CO	Carbon monoxide
DPF	Diesel particulate filter
EPA	Alberta Environment and Protected Areas
GHG	Greenhouse gas
GoA	Government of Alberta
HC	Hydrocarbon
HDDV	Heavy-duty diesel vehicle (e.g., dump trucks, semi-trailer trucks that use diesel as a fuel source)
HDV	Heavy-duty vehicle (e.g., dump trucks, semi-trailer trucks)
ICCT	International Council on Clean Transportation
IRTAQ	Impacts of Reduced Transportation on Air Quality
LDGV	Light-duty gasoline vehicle (e.g., passenger cars, pickup trucks, vans, and SUVs that use gasoline as a fuel source)
LDV	Light-duty vehicle (e.g., passenger cars, pickup trucks, vans, SUVs)
NAPS	National Air Pollution Surveillance (Program)
NO	Nitric oxide
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
NPS	Non-point source
O_3	Ozone
PM	Particulate matter
$PM_{2.5}$	Fine particulate matter
ROVER	Roadside Optical Vehicle Emissions Reporter
RSD	Remote sensing device
SCR	Selective catalytic reduction
SO_2	Sulphur dioxide
U.S. EPA	United States Environmental Protection Agency
VIN	Vehicle identification number
VIS	Vehicle Inspection Station
VOCs	Volatile Organic Compounds

Executive Summary and Recommendations

The CASA Roadside Optical Vehicle Emissions Reporter (ROVER) III Project Team was established in 2018 following the CASA Board's approval of a statement of opportunity from the Government of Alberta (GoA), led by Alberta Environment and Protected Areas (then Alberta Environment and Parks). The team was tasked with measuring emissions from the in-use on-road transportation sector in Alberta, particularly diesel-fuelled trucks, to inform management actions or next steps for transportation emissions management. This project follows up on the work completed in the ROVER I and II projects which measured emissions from in-use on-road light-duty gasoline vehicles (LDGVs) in Alberta.

Opus Inspection Inc. was contracted to collect vehicle emissions data for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs) using remote sensing in five municipalities and select vehicle inspection stations in Alberta. LDV testing was completed in 2020–2022, while HDV testing was completed in 2022. The emissions data was then matched with corresponding vehicle characteristic information for analysis.

Results of the data collection and subsequent analysis showed that most of the Alberta-registered heavy-duty diesel vehicles (HDDVs) measured were newer vehicles (2010 and newer models) and were expected to have the latest emissions control systems. These HDDVs were found to emit nitrogen oxides (NO_x) and particulate matter (PM) at levels significantly above emission benchmarks and above comparable California-registered HDDVs measured with similar technology and under similar operating conditions. About 30% of Alberta HDDV NO_x measurements appear to be at least 10 times the NO_x emission benchmark. These vehicles are suspected to have either malfunctioning or tampered with emission control systems.

Findings for LDVs showed a similar trend, with Alberta-registered LDGVs having significantly higher emissions than both inspected and uninspected vehicles tested in Oregon. Oregon was used as a comparison due to available data and because it is a jurisdiction with vehicle inspection programs in some regions. The tested LDGVs contained more high emitters than the Oregon sample. LDGVs less than 10-years old were also found to harbour significant excess hydrocarbon (HC) and nitric oxide (NO) emissions, which are indicators of emission control system deterioration or malfunctions, and lack of timely maintenance or check engine light response.

The vehicle emissions profile, along with other key information sources, helped inform the development of a suite of recommendations aimed at supporting transportation emissions management. The recommendations are targeted at reducing the incidence of tampering with emission control systems, encouraging routine inspections and maintenance of these systems, additional data collection through emissions testing studies and ambient monitoring, and sharing information on the impacts of tampering and malfunctioning emission control systems on air quality and health. There were two areas of non-consensus that arose during the recommendation development process; those areas are documented and were not included in the suite of recommendations.

The recommendations are outlined below.

Recommendation 1:
Undertake a Future On-Road In-Use Vehicle Emissions Testing Study (ROVER IV)

CASA should collaborate with the appropriate GoA ministries, municipalities, and other stakeholders to plan and implement a future ROVER IV project to collect and analyze emissions data for the in-use on-road vehicle fleets in Alberta.

Recommendation 2:
Increase Near-Road Ambient Air Monitoring

The GoA, in collaboration with appropriate municipalities and corresponding Airshed Organizations, should establish near-road ambient air monitoring within a large urban centre and near a major thoroughfare equipped to monitor ambient impacts from transportation emissions by 2025.

Recommendation 3:
Undertake a Comprehensive Study of Emissions Control Systems and Tampering in Alberta

CASA should establish an expedited project team to undertake a comprehensive study to: a) identify the magnitude and sources of vehicle tampering, including gathering information about manufacturers, sellers, and installers of defeat devices, and b) understand the reliability of installed emissions control devices.

Recommendation 4:
Identify Actions and Initiatives to Reduce Vehicle Tampering

The GoA, upon receipt of the comprehensive study report on emissions controls and tampering in Alberta (recommendation 3), should identify actions and initiatives as needed to address the findings of the study and assess how their implementation could support and further any existing work in this area. This assessment would include determining the key measures and corresponding monitoring and reporting mechanisms required to track the progress and validate the success of identified actions and initiatives.

Recommendation 5A:
Increase Public Awareness and Education on Emissions Control Technology

CASA should work with appropriate stakeholders to plan and implement an awareness and education campaign targeted at the public on the impacts that excess emissions caused by malfunctioning emission control systems may have on air quality and health.

Recommendation 5B:
Increase Heavy-Duty Vehicle Owner and Operator Awareness and Education on Emissions Control Technology

CASA should work with appropriate stakeholders to plan and implement an awareness and education campaign targeted at HDV operators and owners to increase awareness and education on improvements in emissions control technology (e.g., operation and maintenance costs), and issues related to tampering and maintenance.

Recommendation 6:
Provide Incentives for Existing High Emitters to Lower Their Emissions

Organizations, businesses, or other groups that procure the services of transportation carriers should consider requesting information from proponents on the maintenance history of vehicles and membership in programs that promote safety, fuel efficiency, or other sustainable practices (e.g., SmartWay, SmartWay affiliates, Partners in Compliance, Michelin's GreenerFleets), and favour proponents who meet those criteria.

Recommendation 7:
Communicate on Transportation-Related Projects and Support Collaboration Opportunities

CASA should work with other stakeholders to plan and implement a webinar or webinar series to support air literacy and promote collaboration on work related to the transportation sector and its link to air quality.

Recommendation 8:
Use the Results of the ROVER III Project to Update Modelled Incidence and Impacts of Tampering in Canada

International Council on Clean Transportation (ICCT) should update the model inputs used for the "Heavy-Duty Emissions Control Tampering in Canada" project with the emissions data collected through the ROVER III project and re-run the model.

1 Introduction

The Clean Air Strategic Alliance (CASA) was established in March 1994 as a new way to manage air quality in Alberta. CASA supports three air quality management goals:

1. Protect the environment by preventing short- and long-term adverse effects on people, animals, and the ecosystem.
2. Optimize economic efficiency.
3. Promote pollution prevention and continuous improvement.

CASA uses a collaborative, consensus process to develop advice to assess and improve air quality for Albertans.

Throughout this report, the term "partner" is used to refer to organizations that contribute to or support CASA's work, but which are not members of the organization and therefore not represented on the CASA board. CASA and these partner organizations typically share common goals, but there is no formal agreement in place to define that relationship. The use of the word "partner" in this report has no financial or legal implications.

1.1 ABOUT THIS PROJECT

Air emissions need to be managed for Alberta to achieve air quality standards and objectives. Alberta's Renewed Clean Air Strategy (2012)[1] recognizes the need for management actions on non-point sources of air emissions, such as transportation. The transportation sector is one of the largest sources of nitrogen oxides (NO_x) emissions in the province, second only to industrial emissions, and contributes approximately 30% of total NO_x emissions. Management of emissions of NO_x will be needed as the transportation sector is provincewide. In addition to emitting NO_x and other air contaminants with associated health impacts, the transportation sector is a notable emitter of greenhouse gases (GHGs).

When the ROVER III project began in 2018, the Government of Alberta (GoA), led by Alberta Environment and Parks (now Alberta Environment and Protected Areas – EPA), had identified an opportunity for a CASA project team to support Canadian Ambient Air Quality Standard (CAAQS) achievement and general air quality management through an on-road vehicle emissions testing study. The project also supported alignment of provincial initiatives with the intent of federal legislation to reduce air pollutant emissions, including GHGs, from vehicles.

1 https://open.alberta.ca/publications/9781460104767

2 Background

The on-road transportation sector is a large emission source of NO_x, particularly heavy-duty diesel vehicles (HDDVs), followed by light-duty gasoline vehicles (LDGVs). It is also a source of volatile organic compounds (VOCs) and primary fine particulate matter ($PM_{2.5}$).

An on-road vehicle emissions study can: 1) characterize emissions from in-use vehicles (e.g., determine which ages and classes of vehicles have the highest and lowest emissions and whether emissions reality matches perception) in a particular area, such as within the Edmonton to Calgary corridor, or other, 2) identify potential impacts of program and policy options (e.g., design to target highest emitters), and 3) test the feasibility of integrating emissions testing into program options (e.g., for identifying high emitters). It also presents an ideal opportunity for education and raising awareness on vehicle emissions and their impact on air quality.

For the purposes of this report, unless otherwise noted, the term "fleet" is used to refer to vehicles operating in Alberta but makes no claim about their ownership. For example, "Alberta's in-use on-road vehicle fleet" is in reference to all operating vehicles in Alberta and in use on Alberta's roads, regardless of their owner or operator.

2.1 AIR QUALITY STANDARDS AND OBJECTIVES

In Alberta, concentrations of air pollutants at ground-level are measured. Air quality is assessed for the protection of environmental and human health using Alberta Ambient Air Quality Objectives and Guidelines (AAAQOs), and the CAAQS.

Alberta Ambient Air Quality Objectives and Guidelines

The AAAQOs are developed under the Alberta Environmental Protection and Enhancement Act and are intended to protect Alberta's air quality. They are based on scientific, social, technical, and economic factors. AAAQOs have been established for many of the pollutants emitted from the transportation sector, including NO_x and $PM_{2.5}$, which were a particular focus of this work.

The AAAQOs are used to:[2]

- Evaluate the adequacy of facility design in regulatory applications.
- Establish approval conditions for regulated air emission sources.
- Assess beyond project boundary impacts of air pollutant sources and evaluate facility performance.
- Compare to ambient air quality monitoring data to inform Albertans and guide air quality surveys and focused studies.
- Augment reporting of the national Air Quality Health Index to respond to real-time air quality events.
- Report on the condition of the environment in Alberta, including trending and the use of triggers and limits in regional Air Quality Management Frameworks.

Canadian Ambient Air Quality Standards

The CAAQS[3] were established to protect human health and the environment. They have been developed for $PM_{2.5}$, ozone (O_3), nitrogen dioxide (NO_2), and sulphur dioxide (SO_2). They are updated from time-to-time to align with improvements in scientific understanding. They may become more stringent over time and lead to reductions in ambient concentrations which can lead to health benefits. They are measured over a one- or three-year averaging period and then assigned a management level based on the concentration of the pollutant. The CAAQS management levels are:

- Green – Maintain good air quality through proactive air management measures to keep clean areas clean.
- Yellow – Improve air quality using early and ongoing actions for continuous improvement.
- Orange – Improve air quality through active air management and prevent exceedance of the CAAQS.
- Red – Reduce pollutant levels below the CAAQS through advanced air management actions.

2 https://www.alberta.ca/ambient-air-quality-objectives
3 https://www.alberta.ca/canadian-ambient-air-quality-standards

EPA releases annual status of air quality in Alberta: air zones reports which include a summary of the air quality status in Alberta's air zones with respect to the CAAQS and their associated management levels. The most recent report was Status of Air Quality in Alberta: Air Zones Report 2019-2021.[4] Table 2b from the report is included below and shows the CAAQS management levels for each of Alberta's air zones.

TABLE 1: A SUMMARY OF CAAQS AIR QUALITY ASSESSMENTS AND ASSOCIATED MANAGEMENT LEVELS FOR AIR ZONES IN ALBERTA FROM 2019–2021 AFTER REMOVAL OF TRANSBOUNDARY FLOW AND EXCEPTIONAL EVENTS. (SOURCE: STATUS OF AIR QUALITY IN ALBERTA: AIR ZONES REPORT 2019–2021.)

Air Zone	$PM_{2.5}$ Management Level	O_3 Management Level	NO_2 Management Level	SO_2 Management Level
Peace	All stations	Beaverlodge Grande Prairie-Henry Pirker	Beaverlodge Grand Prairie-Henry Pirker	All stations
Lower Athabasca	Fort McKay-Bertha Ganter	Several stations	Several stations	Christina Lake
Upper Athabasca	Hinton-Drinnan	Several stations	Carrot Creek Edson Hinton-Drinnan	All stations
North Saskatchewan	Several stations	Bruderheim	Several stations	Edmonton-Beverly Sherwood Park
Red Deer	All stations	All stations	All stations	All stations
South Saskatchewan	Calgary Central-Inglewood	All stations	Calgary Central-Inglewood	All stations

2.2 EMISSION CONTROL SYSTEMS

An emission control system (or exhaust system) is a crucial component of a vehicle that helps control and reduce harmful emissions released into the atmosphere due to unburnt or evaporated fuel when the vehicle is in operation. Air pollution produced by LDVs and HDDVs consists of carbon monoxide (CO), PM, hydrocarbons (HCs), carbon dioxide (CO_2), and NO_x.

Emission control systems require regular maintenance to function correctly, and if they are poorly maintained or malfunctioning it can result in vehicles emitting many times the emissions they are designed to; this increases their impact on human health and contributes to air quality objective and standard non-achievement.

If vehicle emissions are significantly higher than expected based on the emission control technology available for the vehicle's model year, one of the possible explanations is that those emission controls have been tampered with.

As described by the Canadian Council of Ministers of the Environment (CCME),[5] tampering with vehicle or engine emission controls includes:

- Removing, bypassing, defeating, or rendering inoperative any emission control system device installed in or on a vehicle or engine, including software designed to monitor or control vehicle emissions, or
- Modifying the vehicle or engine in any way that results in increased emissions from the level to which it was originally designed/certified by the manufacturer or importer of the vehicle or engine.

4 https://open.alberta.ca/dataset/9b00aab3-c37d-4080-854e-5f329c621b92/resource/057c65ac-7837-49bb-9528-38c2611540c4/download/epa-alberta-air-zones-report-2019-2021.pdf
5 https://ccme.ca/en/res/tamperingdescription_e.pdf

2.3 HEALTH IMPACTS

Numerous studies on the health impacts of diesel exhaust have been conducted, and a substantial amount of evidence exists to link exposure to diesel exhaust with adverse health outcomes. Health impacts of transportation emissions are more relevant for people living near major thoroughfares and in more populated provinces.[6] In Canada, one third of the population lives within 250 metres of major thoroughfares; this is true for 12% of the population in Alberta.

Chronic and acute diesel exhaust exposure has been found to cause premature mortalities[7] and lung cancer and is associated with bladder cancer.[8] Some individuals are more susceptible to impacts from exposure to air pollution, including the elderly; people with asthma, pneumonia, diabetes, obesity, and respiratory and cardiovascular diseases; and children and newborns. The economic cost of the health impacts of diesel exhaust has been estimated at greater than $5 billion for Canada in 2015, with that impact disproportionately felt in the most populated provinces (Alberta, British Columbia, Ontario, and Quebec).[9]

6 https://publications.gc.ca/collections/collection_2022/sc-hc/H144-91-2022-eng.pdf
7 https://publications.gc.ca/collections/collection_2016/sc-hc/H129-60-2016-eng.pdf
8 https://monographs.iarc.who.int/wp-content/uploads/2018/06/mono105.pdf
9 https://www.canada.ca/en/health-canada/services/publications/healthy-living/human-health-risk-assessment-diesel-exhaust-summary.html

3 Project Description

The project had a clearly defined goal, scope, and objectives which are detailed in this section. This information is taken from the project charter, which can be found in Appendix B.

3.1 GOAL

The project goal was to measure emissions from the in-use on-road transportation sector, particularly diesel fuelled trucks, to inform management actions and next steps for transportation emission management to help achieve the CAAQS in Alberta.

3.2 SCOPE

The work of the project team was limited to using remote sensing technology to test emissions from the in-use on-road vehicle fleet and making recommendations on managing emissions from the on-road transportation sector.

The focus of the work was intended to be diesel-fuelled trucks, but data was also collected on other HDVs (e.g., buses) and LDVs (e.g., personal vehicles). The emissions of focus included NO_x, VOCs, CO, CO_2, and PM for a holistic approach. Recommendations to reduce these substances are expected to have the co-benefit of reducing other emissions.

3.3 OBJECTIVES

The project work plan was broken down into five objectives, each with their own strategies and deliverables.

Objective 1: Compile and review information and agree on a common understanding of current transportation emissions and their management in Alberta and other jurisdictions.

Strategies:

Gather and review existing and planned work on current transportation emissions and their management in Alberta and other jurisdictions.

- Determine any permits or permissions required to undertake the on-road vehicle emissions testing study and the time required to obtain them.

Desired Outcomes:

- An understanding of the work being done in Alberta and elsewhere to measure and manage transportation emissions.
- A list of reference materials on similar and related work on transportation emissions and management in Alberta and other jurisdictions.

Objective 2: Undertake an on-road vehicle emissions testing study to gather data on emissions from in-use on-road LDVs and HDVs, focusing on diesel-fuelled trucks.

Strategies:

- Define the scope of the on-road vehicle emissions testing study including the emission parameters and vehicles of focus (e.g., on-road HDDVs and light-duty diesel vehicles), given available funding.
- Confirm availability of the potential contractor and initiate a contract for the on-road vehicle emissions testing study.
- With input from the consultant, outline the design of the emissions testing study including the number and location of testing sites for representation given available funding, the desired time periods for data collection, and how to address any limitations or risks. The testing site determinations must also consider CAAQS achievement, areas where the vehicles of focus frequent, and the locations used in previous similar studies.
- Obtain any necessary permits or permissions for data collection (e.g., testing site set-up authorization and selected vehicle registration information gathering).
- Obtain registration information for the vehicles testing during the on-road vehicle emissions testing study from Service Alberta.

Desired Outcomes:

- The study is undertaken, and data are collected for the vehicles of focus, emission parameters, and locations during the desired time periods.

Objective 3: Develop a vehicle emissions profile for the in-use on-road vehicle fleet based on data from Objective 2 and compare results from this and similar studies.

Strategies:

- Evaluate and summarize the data collected during the on-road vehicle emissions testing study to characterize the fleet. This includes identifying which model years, classes of vehicles, and fuel types are the lowest and highest emitters. If possible, this would also include comparing emissions profiles of vehicles enrolled in an appropriate program available at the time of the emissions testing study, such as the Partners in Compliance program or the SmartWay Transport Partnership, versus those not enrolled.
- Compare results between the different ROVER III testing sites and ROVER III and similar studies from British Columbia, Alberta, or other jurisdictions highlighting any key similarities or differences.

Desired Outcomes:

- The on-road vehicle emissions testing study report is completed and includes characterization of the fleet and highlights any key results or insights.
- The data collected is provided separately to the report in a format to be decided by the contractor and the project team.

Objective 4: Evaluate and recommend management actions or other next steps to reduce emissions from the in-use on-road vehicle fleet based on the outcomes of Objectives 1 and 3.

Strategies:

- Develop a list of potential management actions and other next steps for implementers (i.e., governments, Airshed Organizations). Additional inputs or considerations should include:
  - input from key stakeholders,
  - considerations for socioeconomic concerns, any advantages or disadvantages to affected stakeholders, and alignment of provincial initiatives with federal legislation with the intent of reducing air and GHG emissions from vehicles, and
  - evaluation of potential management actions and next steps for emitters, leveraging existing available information (e.g., cost/benefit analysis, ease of implementation, feasibility of integrating emissions testing) wherever possible.

Desired Outcomes:

- Recommendations for management actions or next steps to help reduce emissions from the transportation sector in Alberta that are complementary to, rather than duplicative of, existing or already planned initiatives.

Objective 5: Develop and implement a strategy and action plan for communicating the work of the project team, and on vehicle emissions and their impact on air quality.

Strategies:

- Identify existing communication channels that could be leveraged.
- Determine relevant information to be communicated, the appropriate audience, timing, and how it will be communicated.
- Engage stakeholders as required throughout the project.
- Provide advice on stakeholder and public engagement to the implementers of management actions, where applicable.
- Develop messaging on the outcomes of each objective for project team members to communicate relevant information to their constituents.

Desired Outcomes:

- A communications strategy detailing what, how, when and to whom project information will be communicated.
- A message map (or other communication tools) for communicating on vehicle emissions and their impact on air quality via existing communication channels.
- A survey of selected audience(s) to inform future education and awareness activities.

Details on how the project team completed these objectives is included in Section 5 of this report.

3.4 BUDGET

The original budget request to complete this project was $175,000. Most of this budget ($150,000) was dedicated to the costs associated with completing the on-road emissions testing study and subsequent development of a report on the data collection and analysis. When the project was initiated, CASA committed $100,000 from its existing funding that was originally provided by EPA and requested support from other CASA members and partners to obtain the remaining $75,000.

After the project team was initiated, several groups generously donated funding. These groups included the International Council on Clean Transportation (ICCT), Alberta Transportation and Economic Corridors (AT & EC), and the Canadian Fuels Association. These groups donated $100,000, $15,000, and $15,000, respectively. The original budget request was exceeded, with a total of $230,000 available to support the work.

The excess funding over the originally requested $175,000 was applied to the on-road emissions testing and reporting component of the work, which allowed for more days of data collection. This enabled more sampling sites and increased overall sample size for the study, thus contributing toward robust data analysis.

4 Related CASA Projects

CASA has completed several projects on emissions from the transportation sector (summarized below). Details on individual projects can be found on the CASA website.

4.1 ROADSIDE OPTICAL VEHICLE EMISSIONS REPORTER I

In 1998, CASA's Vehicle Emissions Working Group made recommendations to the CASA board to develop a profile of provincial vehicle emissions characteristics and increase public awareness regarding vehicle maintenance and the impact of vehicle emissions on air quality. To address these recommendations, CASA undertook ROVER I, a remote sensing project and collected data in Calgary, Edmonton, Red Deer, and Canmore. The focus of the project was on CO emissions, as it was considered a good indicator of overall vehicle performance. Data was collected for 42,295 LDVs over the course of October and November in 1998.

Based on the data collected, the project team made the following observations:

- For the vehicles tested, 7% of gross emitting vehicles were responsible for 54% of CO emissions. In comparison, the 81% clean vehicles produced only 18% of CO emissions.
- Thirty-seven percent of the vehicles had no measurable amounts of CO (i.e., less than 0.05% CO).
- The median CO emissions in the four municipalities was 0.11% CO. That served as a baseline for Alberta's in-use vehicle emissions profile.
- The results were very similar among the four municipalities; any variation between them was not statistically significant.
- The majority of LDVs observed in each municipality had only one occupant.
- Public awareness and interest in vehicle emissions was evident.

Three recommendations resulting from the project were presented to the CASA board and approved in March 1999. The recommendations were:

1. A snapshot of vehicle CO emissions characteristics has been established. Remote sensing has proven to be an effective method of collecting this data. Therefore, CASA should continue to look into this method of testing and repeat it in three to four years to assess changes to the base profile. In addition, CASA should look at testing for additional pollutants (e.g., NO_x, total HCs) at that time.
2. While the report defines gross emitters (i.e., greater than 3% CO emissions) it is unknown as to exactly why they are emitting at high levels. Possible reasons are lack of maintenance, tampering with vehicle emission control systems, or equipment failure. Identifying root causes for gross emitters should be considered in future work.
3. The evidence shows that there is potential for reducing emissions by targeting the gross emitter, and initially, programs that focus in this area may be more cost-effective than a program that targets all vehicles. Based on targeting the worst offenders, the following actions are recommended:
    a. Investigate the mechanisms for eliminating visible gross emitters.
    b. Investigate the legislative option to address tampering of vehicle emissions systems, which in many instances will convert a clean vehicle into a gross emitter.
    c. Promote programs that remove older vehicles from the road (scrappage), or that encourage regular maintenance (Smog Free[10]), and smart vehicle purchase and operations (Auto$mart[11]).

All the recommendations made through the ROVER I project were further investigated and resulted in additional remote sensing projects (ROVER II and III), a partnership between CASA and the Calgary Kidney Car Program and Calgary Pick Your Part to run a pilot scrappage program, and further projects to target high emitters (e.g., a Diesel Particulate Filter Test project).

The ROVER I project report is available on the CASA website.[12]

10 https://smogfreeclarkcounty.com/
11 https://natural-resources.canada.ca/energy-efficiency/transportation-alternative-fuels/personal-vehicles/automart-driver-training/21042
12 https://www.casahome.org/uploads/source/Alberta_ROVER_Project_(March_1999).pdf

4.2 ROADSIDE OPTICAL VEHICLE EMISSIONS REPORTER II

CASA began the ROVER II project in 2006 to expand on the work completed in ROVER I and to determine what progress had been made and what policies may be needed to control emissions from the transportation sector in the future. Data was collected for 66,002 LDVs at the same four municipalities as in ROVER I (Edmonton, Calgary, Red Deer, and Canmore). Technology advances since the completion of ROVER I allowed for measurement of parameters additional to CO, including HCs, NO_x, and PM. Licence plates for the tested vehicles were recorded and CASA partnered with Service Alberta to use the licence plates to obtain vehicle characteristic information.

The key findings of the project included:

- On-road emissions per vehicle were lower than in the ROVER I project.
- Median emission levels were similar in all four municipalities.
- Twenty percent of LDVs accounted for 80% of exhaust emissions of hydrocarbons, CO, NO_x, and PM.
- The gross emitters were older, heavier vehicles, or those fuelled by propane.
- The gross emitter rate among 1996 and new models was less than 2%, versus 20–40% for 1989 and older models.
- Three quarters of vehicles had only one occupant. Occupancy levels were similar to those in ROVER I apart from Canmore, where there was an increase in the number of vehicles with multiple occupants.
- Public awareness and interest in vehicle emissions was evident.

The ROVER II project did not result in formal recommendations but drew the conclusion that a stand-alone high emitter program could identify the small percentage of high emitters and encourage owners to obtain repairs or scrap the vehicle.

The ROVER II project report is available on the CASA website.[13]

4.3 NON-POINT SOURCE

CASA undertook the non-point source (NPS) project to support management of non-point sources. The 2011–2013 Air Zones Report[14] indicated that five of the six air zones in Alberta were either approaching or not achieving the CAAQS for $PM_{2.5}$, and one air zone was approaching the CAAQS for O_3. The project focused on NPS emissions that contributed to ambient $PM_{2.5}$ and O_3 where air quality was approaching or not achieving the CAAQS, with the goal of recommending management actions to reduce air emissions from non-point sources in those areas.

The project team completed a review of NPS air emissions in Alberta and assessed their potential contributions to air quality in the zones that were approaching or not achieving the CAAQS for $PM_{2.5}$ and O_3. The report presented recommendations related to mobile sources (transportation), construction operations and road dust, open-air burning, commercial and residential heating, industrial non-point sources, land-use planning, addressing NPS knowledge gaps and uncertainties, and considering the air quality co-benefits of climate change initiatives. Emissions from the transportation sector were considered a priority, with nine of the 17 recommendations targeted at NPS emissions from that sector.

Of relevance to the ROVER III project, recommendation 8 from the NPS project report was:

> That Alberta Environment and Parks and Alberta Transportation, in collaboration with appropriate stakeholders, undertake an innovative on-road emission testing study.

ROVER III is the implementation of that recommendation.

The NPS project report is available on the CASA website.[15]

13 https://www.casahome.org/uploads/source/PDF/ROVERII_Report_FINAL-8JAN2008.pdf
14 https://open.alberta.ca/publications/alberta-air-zones-report-2011-2013
15 https://drive.google.com/file/d/1M5Aq9AZA_QO0vEVFO44sR77vz8mo6EsX/view

4.4 IMPACTS OF REDUCED TRANSPORTATION ON AIR QUALITY IN ALBERTA ASSOCIATED WITH COVID-19

The goal of the Impacts of Reduced Transportation on Air Quality in Alberta Associated with COVID-19 (IRTAQ) project was to collaboratively develop messaging that linked changes in air quality associated with measures undertaken to reduce the spread of COVID-19. The messaging aimed to generate provincial awareness of the impacts that reductions in motor vehicle transportation could have on air quality, and how individuals, governments, businesses, and other Albertans could act to improve it.

The project report was released in August 2022 and summarized information about air pollution and its associated human health impacts, along with information and data analysis results on Alberta's ambient air quality and traffic counts before and during the implementation of measures to reduce the spread of COVID-19. The key messages were the primary outcome of the project, and were divided into three categories:

1. ambient air quality during the study period relative to past conditions,
2. contribution of reduced transportation to improved air quality, and
3. impacts of air quality on human health.

In addition to the key messages, the team also provided examples of measures and actions that individuals, governments, industry, and organizations could take to reduce transportation-related emissions.

The CASA board approved the following recommendations from the IRTAQ project:

1. For CASA to provide the final key messages, and guidance on delivering those messages, to its stakeholders and partners.
2. For stakeholders and partners to deliver the key messages to audiences through their networks.
3. For Alberta Environment and Parks to prepare the air quality and vehicle count analysis for peer-reviewed publication.
4. For monitoring organizations in Alberta to investigate air quality near major roadways through roadside ambient air monitoring and compare measured values to nearby neighbourhood scale stations.

The goal and scope of the IRTAQ project overlapped heavily with that of ROVER III. Where possible, the ROVER III Project Team strived to support and reinforce the messaging and utilize the partnerships established through the IRTAQ project.

The IRTAQ project report is available on the CASA website.[16]

4.5 CANADIAN AMBIENT AIR QUALITY STANDARDS ACHIEVEMENT

The goal of the CAAQS Achievement project was to promote stakeholder awareness of, and gather cross-sector perspectives on, NO_2 CAAQS air quality issues and to identify and collaboratively develop potential approaches and solutions that have the support of implementers to manage NO_x emissions to prevent CAAQS exceedances. The project was completed in early 2023, and its outcomes included a background document on Alberta's air quality management system (AQMS), a summary of webinar proceedings, and a table of potential options to reduce NO_x emissions.

The potential options were broken down into theme areas, and several are relevant to the ROVER III project. Those themes included:

- traffic/urban planning
- transition from combustion to electrification
- transportation emission limits
- transportation regulations
- transportation upgrades

The ROVER III Project Team took these themes into consideration when developing their own recommendations for management actions and next steps to manage emissions from the transportation sector.

The CAAQS Achievement project report is available on the CASA website.[17]

16 https://www.casahome.org/uploads/source/CASA_IRTAQ_Final_Report-compressed.pdf
17 https://www.casahome.org/uploads/source/Dust_Project/CAAQS_Achievement/Approaches_and_Solutions_for_CAAQS_Achievement_in_Alberta_Final_Report.pdf

5 Methods

All CASA groups and teams, including the ROVER III Project Team, make decisions and recommendations through a collaborative consensus-based approach that uses interest-based negotiation. This section describes that approach, and how the Project Team collected vehicle emissions data.

5.1 CASA'S CONSENSUS PROCESS

CASA's Guide to Managing Collaborative Processes outlines the processes and procedures used to reach consensus between diverse groups of participants, and every person who joins a CASA group is expected to participate in a way that is consistent with the Guide. A commitment to following the consensus process is critical to the success of all CASA teams.

The ROVER III Project Team members received an orientation on the consensus-based process and interest-based negotiation. CASA staff helped facilitate the discussions in a way that focused on interests, rather than positions. Throughout the project, team members were encouraged and expected to frequently engage with their sectors to ensure they could represent the interests of their group for each topic under discussion.

Occasionally, teams are unable to find a resolution to an issue that is satisfactory for all parties involved. Several options are available to project teams to address non-consensus areas. The team may choose to document the area of non-consensus in the project team report. Alternatively, they can undertake a perspectives document process, where each CASA member can choose to submit a document outlining their sector's perspective on the issue and it is then appended to the project report along with any other perspective documents submitted.

The ROVER III Project Team was unable to reach consensus on two topics, and rather than undertaking a perspectives document process, they opted to document these areas of non-consensus in Section 8.

5.2 IMPACTS OF COVID-19 AND ASSOCIATED MITIGATION MEASURES

This project was started in 2018 with a goal of completing the work by 2020. The COVID-19 pandemic began before the project work was finished and the mitigation measures implemented to prevent the spread of COVID-19 impacted the team in several ways.

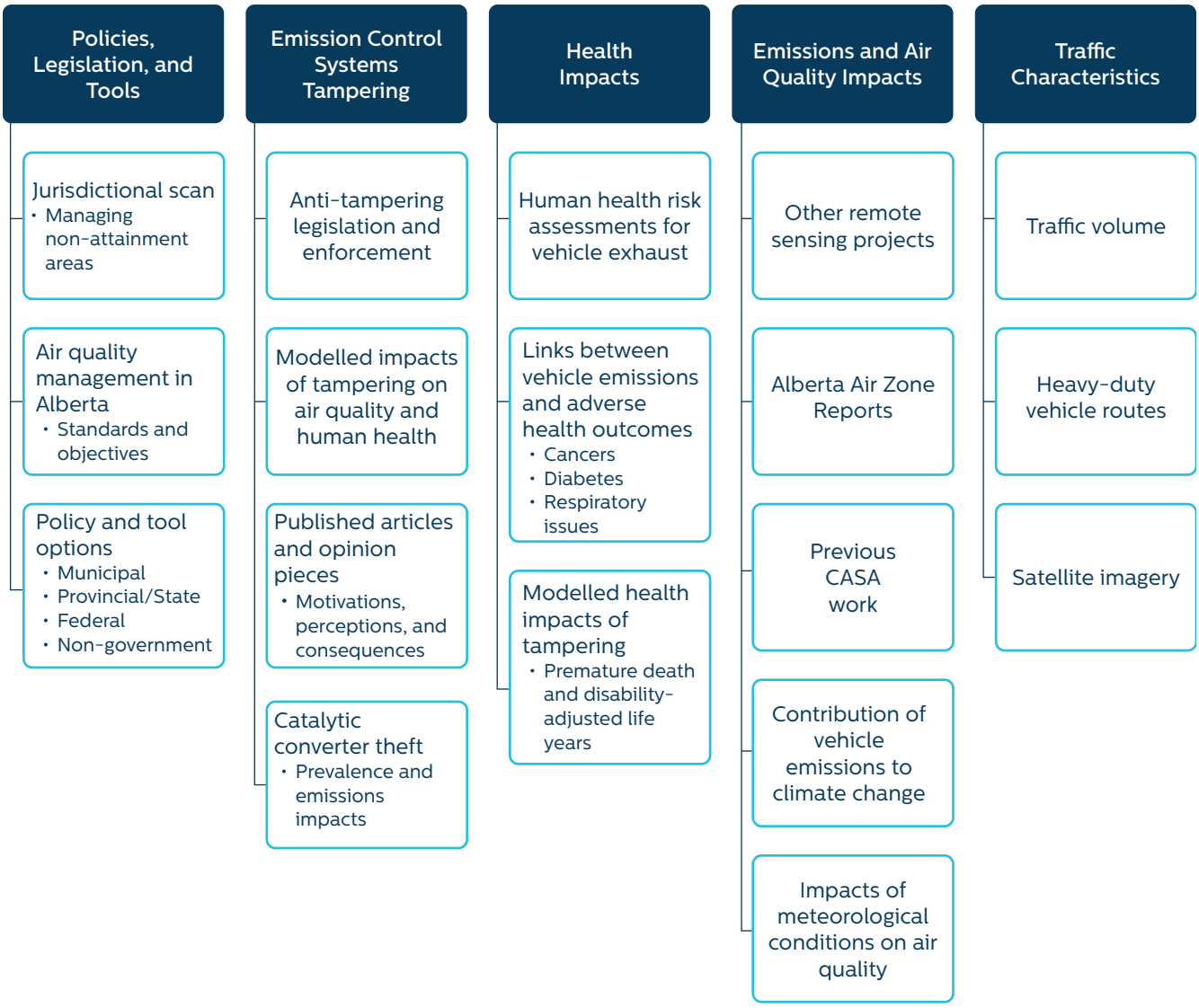
Initially, there was a several months-long pause in the work as many organizations transitioned from office-based work to either a full or part-time work from home arrangement. After the initial pause, project team meetings were held remotely rather than in-person. This change in format resulted in meetings being shorter but held more frequently. The methods team members used to engage with other participants and the work itself changed as a result. While more frequent meetings may have been beneficial, collaboration is often less effective when using remote platforms compared to in-person meetings.

5.3 INFORMATION GATHERING

The project team drew on a variety of information sources to establish a common understanding of emissions from the transportation sector and potential methods to manage them. Source types and content categories are included in Figure 1. A full listing of all references used in the development of this report and recommendations are found in Appendix C.

While the focus of this work was limited to management of transportation emissions related to air quality standards and objectives, many of the sources reviewed included information on the contribution of transportation emissions to climate change. Inclusion of those reports in this section and in Appendix C are meant to document the information sources available to the project team and are not an implication that climate change was included in the project scope.

FIGURE 1: SUMMARY OF THE TOPIC AREAS REVIEWED TO HELP INFORM THE ROVER III PROJECT'S RECOMMENDATIONS.



5.4 VEHICLE EMISSIONS TESTING

Vehicle emissions testing was a core component of the project and much of the initial work undertaken by the team was to ensure the data collection campaign was robust and would improve knowledge on Alberta's in-use on-road vehicle fleet.

Site Selection

One of the early tasks for the project team was to identify appropriate sites where remote sensing equipment could be set-up and emissions data recorded for the vehicles travelling on the adjacent roadway. The project team established criteria which had to be met for a site to be considered for data collection:

- It was located within or near Fort McMurray, Grande Prairie, Edmonton, Red Deer, or Calgary to allow for comparisons between results from the ROVER III project and ROVERs I and II.
- The site's configuration allowed the remote sensing equipment to capture a single lane of traffic.
- The road grade at the site is a slight incline, so vehicle emissions could be captured while the vehicle accelerated.
- Traffic volume was high to ensure a high number of measurements could be taken during the one to three days spent at the site.

Additional considerations included proximity to ambient air monitoring stations, permitting requirements, and safety for personnel operating the remote sensing equipment.

The project team hosted a workshop in August 2018 which included the project team members, subject matter experts, and staff from Opus Inspection Inc. (Opus) to review available information and make selections for the remote sensing sites in each of the five municipalities.

Available information included satellite imagery, truck route maps, traffic flow maps and statistics, and construction schedules for both prospective sites and in adjacent areas. The team also sought advice from people familiar with the areas on suitability of the sites for traffic volume and type, ability to set-up the remote sensing equipment, typical speed and acceleration of the vehicles as they pass the site, and daily or hourly variations in traffic flow. Not all information types were available for all municipalities, but a subset was available for each.

After sites were selected, CASA staff worked with Opus staff to secure the appropriate permits to allow the remote sensing equipment to be set-up and data collected at those locations.

Data Collection and Analysis

Details on the equipment, methodology, data analysis and results used for this project can be found in the report Roadside Vehicle Emissions Reporter III: A Survey of On-Road and Light and Heavy-Duty Vehicle Emissions,[18] prepared by Opus for CASA in 2023. This section contains a high-level summary of the data collection methodology.

CASA contracted Opus to collect LDV and HDV data in Fort McMurray, Grande Prairie, Edmonton, Red Deer, and Calgary. Several factors contributed to delays in initiating the data collection phase of the project:

- Technology improvements were underway for the remote sensing equipment that could have allowed ammonia data to be collected in addition to the other parameters. The project team decided to delay the data collection with the intent of the improved remote sensing equipment being used for this study, but ultimately it was not available.
- Border closures related to reducing the spread of COVID-19 prevented Opus staff from crossing into Canada; once crossing was allowed, strict quarantine measures were required which would have greatly increased the amount of time staff would have had to spend in Canada (e.g., 10 days of isolation following entry into the country, during which data collection could not be undertaken).
- Decreases in traffic volume due to measures taken to mitigate the spread of COVID-19 resulted in a need to change study sites to more productive locations.
- Service Alberta's registration database, which was the source of the vehicle characteristic data used in Opus's data analysis, was under maintenance during 2018–2019, causing the data sharing agreement to be signed at a later point in the project than anticipated.

Due to these delays, the main data collection effort was postponed from 2019 until 2022; however, there was an opportunity for a short pilot study in 2020. The pilot took place in Edmonton and involved Opus, the University of Alberta, and EPA. Results from this pilot study showed low traffic volume for HDVs at the selected sites in Edmonton, and as a result the project team decided to move the HDV data collection to vehicle inspection stations (VISs). Opus worked with CASA staff, AT & EC, EPA, and Sheriff Highway Patrol to gain the required permits and coordinate staffing and opening schedules for the VISs to allow this change in data collection sites.

Vehicle Characteristic Data

The project team engaged Service Alberta early in the project for access to vehicle characteristic information tied to vehicle licence plates. Access to this vehicle characteristic data was requested to support a more robust analysis of the collected emissions data.

CASA entered an Access to Motor Vehicle Information Regulation (AMVIR) agreement with Service Alberta. This agreement outlined the information on each vehicle that would be supplied to CASA by Service Alberta, along with information on how the information could be used and how it must be treated to maintain confidentiality.

The information on each vehicle provided by Service Alberta was:

- vehicle year, model, and make
- fuel type
- vehicle weight
- client postal code (first three digits)
- vehicle body style
- vehicle identification number (VIN)
- vehicle plate class

18 https://www.casahome.org/uploads/source/ROVER_III_Opus_Report-Final_Nov_2023_(amended)_v.2.pdf

This information was retrieved from a Service Alberta database using licence plate numbers collected by Opus staff during data collection.

Together, a vehicle's licence plate number and its VIN constitute personally identifiable information. To ensure privacy for the registered vehicle owners, the dataset was de-identified by removing the licence plate numbers and replacing them with a numerical identifier, so no dataset was retained that contained licence plate numbers associated with vehicle VINs. This ensured the emissions data could be tied to the vehicle's characteristics without including any personally identifiable information.

The AMVIR agreement further specified that any publications using the vehicle registration information must use aggregated data and not include VIN or licence plate information. The de-identified dataset was provided to Opus and used in their analysis, the results of which are presented in their report as aggregated data.

CASA's AMVIR agreement with Service Alberta identifies the Government of Alberta as a partner who can receive the emissions and vehicle characteristic dataset generated through this project. Opus, the University of Alberta, and the ICCT are also identified in the agreement and can receive and retain the de-identified version of the dataset. If these parties wish to publish any work that uses the data from this project, they are also bound to the requirements of the AMVIR agreement and must only publish aggregated data with the licence plate information and VIN withheld.

6 Results of the Data Collection and Analysis

This section summarizes the results of the analysis completed by Opus for CASA. Details of the analysis and its results can be found in Opus's report on the CASA website.[19]

For their analysis, Opus acknowledged that it is not uncommon for real-world emissions to be higher than emissions recorded under the laboratory conditions used for standardized new vehicle certification test cycles. The analysis involved comparison to these laboratory certifications, referred to in the report as emissions benchmarks, and are meant to provide a point of reference rather than definitive indication of non-compliance with emissions standards. Egregious exceedances (at least 10 times higher than the benchmark) are indicative of emissions control systems that have either been tampered with or are malfunctioning.

6.1 SUMMARY OF RESULTS: LIGHT-DUTY VEHICLES

Between 2020–2022, Opus collected 49,747 emissions measurements from LDVs at sites in Fort McMurray, Grande Prairie, Edmonton, Red Deer, and Calgary. Of those measurements, 41,724 were matched with vehicle characteristic data from Service Alberta. Most of the vehicles (67%) were light trucks, which includes SUVs, pickup trucks, and vans. The vehicles were primarily fuelled by gasoline or gasoline blends (94.9%), with the remainder being diesel-fuelled. Because so few vehicles were diesel-fuelled, the LDV analysis completed by Opus was limited to gasoline-powered vehicles. Analysis was also limited to 2003 and newer vehicle models, which made up 97% of the LDV measurements.

Comparison to emission benchmarks yielded the following results:

- 17% of observations exceeded the CO benchmark
- 55% of observations exceeded the HC benchmark
- 37% of observations exceeded the NO benchmark

Overall, emissions from LDVs have decreased substantially compared to the data collected in the ROVER II project, particularly for hydrocarbons and NO. However, all model year groups still contain high emitters, even in the newer model year group (2013 and later) which would be expected to meet emissions benchmarks. ROVER II reported that the highest emitting vehicles (top 5%) were responsible for 31% of HC emissions; in ROVER III, that number has further skewed with the top 5% highest emitting vehicles now accounting for 64% of HC emissions.

Opus compared the Alberta results with data collected in Oregon using similar remote sensing technology. Oregon has mandatory periodic vehicle emission inspections in Portland and Medford, and repairs are required for vehicles with high emissions. The ROVER III results were compared both to the areas with mandatory emissions inspections and those without. Generally, the Alberta fleet had greater emissions and a higher percentage of high emitters than Oregon, for both the inspected and uninspected Oregon vehicle fleets. While the reasons for this are varied, it is likely inspection requirements play a role in reducing LDV emissions.

6.2 SUMMARY OF RESULTS: HEAVY-DUTY VEHICLES

In 2022, 6,338 valid HDV measurements were collected at the Airdrie, Whitecourt, Leduc, Atmore, and Coutts VISs. Of those observations, 2,928 were matched with vehicle characteristic information from Service Alberta. Where licence plates could not be captured, as was the case for dump and delivery trucks, Opus used other identifying information for individual vehicles or commercial fleets observed multiple times. Most vehicles were registered in Alberta, but 17% were registered outside of the province and therefore Service Alberta could not provide vehicle characteristic data for them.

Comparisons to emission benchmarks yielded the following results:

- 62% of observations exceeded the NO_x benchmark
- 72% of observations exceeded the PM benchmark
- 0% of observations exceeded the CO benchmark
- 45% of observations exceeded the HC benchmark

Notably, approximately 30% of vehicles observed were at least 10 times the benchmark for NO_x, and 10% of observations were at least 10 times the benchmark for PM. As previously noted, this is indicative of these vehicles either having malfunctioning or tampered with emission control systems.

Previous ROVER projects focused on LDVs and did not include analyses for HDV emissions, so comparisons

19 https://www.casahome.org/uploads/source/ROVER_III_Opus_Report-Final_Nov_2023_(amended)_v.2.pdf

to ROVER I and II are not possible. However, Opus compared Alberta's results with those from data collected from the agricultural inspection station in Mountain Pass, California. The weather and temperature conditions for the California data collection were comparable to the conditions for ROVER III's data collection. The comparison showed that NO_x and PM emissions for HDVs registered in Alberta were much higher than those registered in California, and a greater percentage of Alberta's fleet are likely to have malfunctioning or tampered with NO_x and PM emission control systems.

Objective 3 of the project charter included a comparison of emissions profiles of HDVs enrolled in programs such as Partners in Compliance or the SmartWay Transport Partnership to those which were not enrolled. This comparison could not be completed because CASA was unable to obtain information for individual vehicles on their registration in these programs.

6.3 MODELLED HEALTH IMPACTS

The ICCT produced a report in 2022 titled Heavy-Duty Emissions Control Tampering in Canada. The project involved modelling impacts of emission control system tampering of HDDVs on fleetwide emissions for Canadian provinces. The impact of those emissions on health were then estimated using the Fast Assessment of Transportation Emissions (FATE) model. The FATE model estimates health impacts in terms of premature deaths and disability-adjusted life years based on $PM_{2.5}$ and O_3 concentrations from pollutant emissions.

When this study was complete, ICCT did not have concrete evidence on the prevalence of HDV emission control tampering in Alberta. Modelling was based on three scenarios with low, medium, and high tampering incidence. For HDVs in Alberta, these scenarios were 6.7%, 10.0%, and 13.3%, respectively. The ROVER III project did not include vehicle inspections to determine the cause of excessive emissions from HDDVs and therefore cannot determine what proportion of the 30% of high-emitting vehicles are tampered with as opposed to having malfunctioning emission control systems. However, whether emission control systems have been defeated or are non-functioning, the result is the same for excess emissions. Therefore, the modelling scenarios used for ICCT's work may underrepresent the excess emissions and the resulting health impacts of these vehicles.

ICCT estimated that cumulatively over the next 20 years, pollution from non-tampered with HDDVs will cause a total of 4,670 premature deaths and 84,000 disability-adjusted life years in Canada. For each 1% increase in the fraction of the Canada's HDDV fleet that has been tampered with, that estimate increases by 690 additional premature deaths and 11,800 disability-adjusted life years. The medium tampering scenario results in an additional 5,700 premature deaths and 96,700 disability-adjust life years by 2040, nation-wide.

The ROVER III results indicate that tampering prevalence in Alberta likely exceeds even the high tampering scenario, and Albertans do and will continue to experience an increased health burden unless measures are taken to lower emissions from high emitters.

For additional detail and to view ICCT's full report, please visit the report's webpage.

7 Recommendations

These recommendations are a suite meant to work together to support reducing emissions from Alberta's on-road in-use vehicle fleet. The recommendations include both LDVs and HDVs, however the project focus was diesel-fuelled trucks due to a need for careful management of NO_x emissions for Alberta to achieve NO_x air quality standards and objectives. While LDVs emit less NO_x than HDVs, they are a source of other pollutants (e.g., VOCs), and reducing emissions from LDVs will also provide air quality improvements and reductions in adverse health impacts.

The recommendations were developed to acknowledge, add on to, or complement both transportation-related recommendations made by previous CASA teams and transportation-related work being undertaken by other organizations without duplicating efforts. For each recommendation, rationale, considerations for implementation, and a method of measuring the recommendation's performance are provided. The implementers for these recommendations were identified by the project team to the best of their knowledge at the time this report was written.

The scope of the recommendations reflects a range of themes, including:

- Information gathering to support effective management of transportation emissions over time.
- Actions to reduce possible tampering with emission control systems and improve compliance with maintenance requirements.
- Improvement of education and awareness on transportation emissions and the impacts of tampering and lack of maintenance of emission control systems.
- Support for transportation-related work and opportunities for collaboration.

The order in which these recommendations are presented is not meant to imply priority.

Recommendation 1:

Undertake a future On-Road In-Use Vehicle Emissions Testing Study (ROVER IV)

CASA should collaborate with the appropriate GoA ministries, municipalities, and other stakeholders to plan and implement a future ROVER IV project to collect and analyze emissions data for the in-use on-road vehicle fleet in Alberta.

Rationale

Collecting data on Alberta's transportation sector through remote sensing technology would improve our understanding of the in-use on-road vehicle fleet in Alberta and, through comparisons with the results from previous ROVER projects, inform us about emissions trends from the Alberta fleet over time. Data collected through this recommendation can also be used to support future programs, actions, or initiatives designed to reduce transportation sector emissions and evaluate their effectiveness.

In addition, this recommendation aligns with the recommendation made by ICCT to use remote sensing and roadside emission inspections as a market surveillance tool against tampering.[20]

Implementation Considerations

A ROVER IV project would have many considerations, some of which are outlined below.

Administration

- CASA's involvement would allow the use of CASA's existing agreement with Service Alberta to obtain vehicle registration information to pair with emissions data. Using the existing agreement could considerably reduce the cost and time required to initiate a data collection campaign.
- Currently, there is only one known provider of remote sensing services for vehicle emissions measurement in North America, leading to reduced cost flexibility and scheduling challenges. Engaging the provider as early in the process as possible may lead to more timely data collection and analysis.
- A report on the data collection and emissions trends should be developed and made publicly available.

20 https://theicct.org/publication/hdv-emissions-tampering-can-mar22/

Study Design

- Consistency, where appropriate, for comparison with results from the CASA ROVER III project, including:
  - Data collection during the summer or fall months at the VISs and municipal sites utilized for the ROVER III project while also considering unique data collection opportunities (e.g., collecting data on specific fleets such as transit or school buses, commercial fleets, or corporate fleets).
  - Data collection for at least three days at each VIS and at least one day at each municipal site.
- Data collection during both warm and colder months to help assess the impacts of cold weather on vehicle emissions.
- Technology improvements can allow data collection for additional parameters above those collected in ROVER III (e.g., ammonia).
- Trends in vehicle emissions over time should be used to help evaluate the effectiveness of management actions aimed at reducing emissions from the transportation sector.
- Data needs for emissions inventory and modelling projects that use transportation emission data (e.g., tampering impacts or incidence, atmospheric dispersion models, health impact models).
- Investigation of methods to detect tampering that could be incorporated into the data collection campaign (e.g., particulate number counting instruments to detect diesel particulate filter removal, tampering, or other malfunctions).

Partners

- Municipalities (e.g., City of Edmonton and City of Calgary) can provide supporting information on traffic flow and volume in urban centres to support data analysis.
- Academic institutions such as the University of Alberta and Simon Fraser University should be involved in the project due to their involvement in ROVER III, and their ongoing research on emissions from Alberta's transportation sector.
- The Alberta Motor Transport Association (AMTA) can provide support in several areas, such as site selection for HDVs.
- GoA ministries not represented on the CASA board can provide support for various aspects of the project, from administrative components (e.g., permitting requirements and access to registration information) and study design (e.g., site selection, data analysis, comparisons to ambient air monitoring data). These ministries could include Alberta Transportation and Economic Corridors, Alberta Health, Service Alberta, and Alberta Justice.

Potential Funding

- Environment and Climate Change Canada's funding programs
- National Sciences and Engineering Research Council of Canada Alliance Grants
- Mathematics of Information Technology and Complex Systems (Mitacs) Grants

Funding opportunities should be investigated early in the project to ensure relevant deadlines can be met.

As a desired outcome of this project would be to support assessment of actions taken to reduce vehicle emissions, it is recommended there be at least five years between ROVER III and ROVER IV to allow time for actions to be implemented and potentially impact vehicle emissions.

Performance Evaluation

Status of this recommendation can be tracked through CASA's recommendation tracking process as part of CASA's overall performance measurement strategy. The data collection campaign should begin implementation by late 2029 at the earliest, and progress will be assessed during CASA's recommendation tracking process in 2030.

Recommendation 2:

Increase Near-Road Ambient Air Monitoring

The GoA, in collaboration with appropriate municipalities and corresponding Airshed Organizations, should establish near-road ambient air monitoring within a large urban centre and near a major thoroughfare, equipped to monitor ambient impacts from transportation emissions by 2025.

Rationale

Ambient air monitoring near major transportation corridors can provide information on pollutant concentrations related to the transportation sector. That information can be used to identify trends in air quality near transportation corridors and to compare with results from more focused and shorter-term data collection campaigns, such as ROVER IV. Consistent data from such a station could support an assessment of the effectiveness of management actions taken to reduce emissions from the transportation sector over time and could help address data gaps such as the need for updated emissions inventories for large municipalities.

Regular and ongoing near-road ambient air monitoring can also be helpful for municipalities. Municipalities consider ambient air quality impacts in municipal planning, and they are specifically responsible for most road designs. Road designs are supported by transportation modelling, and ground measurements from ambient air monitoring stations could be used to validate those models. Some municipalities also have strategic plans which include a climate resilience priority with goals to have clean air; for example, *ConnectEdmonton 2050 Vision and Council's Strategic Plan (2019–2028)* includes climate resilience as a strategic goal and identifies air quality as an indicator for monitoring change and impact to climate resilience. It would be beneficial for municipalities to track and understand air quality to provide effective management and provide evidence of the municipalities' efforts in this area, and to allow opportunities to pilot programs that could support air quality management.

Implementation Considerations

EPA, municipalities, and Airshed Organizations should leverage relationships to determine an appropriate location for the air monitoring station(s) and identify roles and responsibilities related to operation of the station and reporting requirements. EPA or Airshed Organizations could lead the station establishment, data collection, and reporting from the station, while municipalities would need to be involved in site selection and access, permitting, and utilities. There is also an opportunity for better information sharing on how municipal governments can support air quality monitoring and management.

There are other ongoing or planned projects to collect air monitoring data near transportation corridors, and a committee could be formed with members of these organizations to increase information sharing, identify collaboration opportunities, and create a more robust understanding of impacts from the transportation sector in the province. Such a committee would benefit from multi-stakeholder perspectives, and CASA could be considered as an appropriate forum for the committee, provided funding and capacity are available. Updates on monitoring and data sharing could be provided through existing platforms, for example the Air Data Warehouse, Airshed Organizations, and CASA.

Examples of these ongoing and planned projects include:

- *Near-Road Monitoring Study (Winter 2020):* EPA completed a near-road ambient air quality monitoring-focused study in winter 2020 at a central location in Edmonton.
- *Near-Road Air Monitoring Station (in progress, 2024):* EPA is working with Environment and Climate Change Canada to plan for a near-road ambient air monitoring station in Calgary as part of the National Air Pollution Surveillance (NAPS) Program[21] to further understand the impact of vehicle emissions on ambient air quality near roadways.
- *Future of Transportation in a Cold Climate (in progress, 2024):*[22] A project being completed through a collaboration between the University of Alberta and Simon Fraser University to develop necessary tools and methodologies for analyzing, understanding, and developing transportation decarbonization pathways in cold climate cities. Project leads are Professor Bob Koch and Professor Mahdi Shahbakhti, University of Alberta, and Professor Vahid Hosseini, Simon Fraser University.

Results of programs being undertaken in other jurisdictions could also support greater understanding of air quality in Alberta, such as the network of near-road monitoring in major cities being established through the NAPS Program.

CASA's IRTAQ project made a recommendation for monitoring organizations in Alberta to investigate air quality near major roadways through roadside ambient air monitoring and compare the values to nearby neighbourhood air monitoring stations. This recommendation to establish an ambient air monitoring station near a roadway in a large urban centre would support the IRTAQ project's recommendation through contribution of data for the comparison.

Performance Evaluation

Data from the newly established near-road ambient air monitoring station should be publicly available starting in 2026. Updates on this should be provided to the CASA board via the regular updates provided by the EPA.

21 https://open.canada.ca/data/en/dataset/1b36a356-defd-4813-acea-47bc3abd859b
22 https://www.sfu.ca/see/research/sustainable-urban-transportation/projects/urban-transportation-emissions-and-ghgs.html

Recommendation 3:

Undertake a Comprehensive Study of Tampering in Alberta

CASA should establish an expedited project team to undertake a comprehensive study to: a) identify the magnitude and sources of vehicle emission control tampering, including gathering information about manufacturers, sellers, and installers of defeat devices, and b) understand the reliability of installed emission control devices.

Rationale

The ROVER III project collected emission information from the in-use on-road vehicle fleet in Alberta. The emissions data is necessary to support understanding of air quality impacts from the transportation sector, but this study did not include vehicle inspections. Therefore, the results of this work cannot explain the cause(s) when vehicle emissions significantly exceed the expected benchmarks based on the vehicle's model year. The assumption made in this project is these vehicles have emission control systems that have either been tampered with or are malfunctioning.

There is a need for actions and initiatives from the GoA to help address these excess emissions. The prevalence and sources of emission control system tampering in Alberta is a knowledge gap. Additional focused data collection on manufacturers, sellers, and installers of defeat devices can support the GoA in the identification, design, and implementation of these initiatives.

Implementation Considerations

A data-gathering study to address the knowledge gaps around emission control system tampering is well-suited for an expedited CASA project team. This work would benefit from the multi-stakeholder perspectives of the CASA members and partners who have been involved in the ROVER III project and have spent over five years developing an understanding of tampering and its environmental, social, and economic context.

Typical CASA project teams can take up to three years to complete from identification of the project idea to approval of final deliverables. Because this study would not require consensus recommendations from the project team, this timeline can be significantly shortened. Other potential methods to expedite the project team include:

- A condensed project charter can be developed based on the scope and rationale identified by the ROVER III project team, reducing the amount of time required for initiation of a new team.
- Membership of the ROVER III project team could carry over to the new working group and project team as those individuals have the required knowledge and relationships with other organizations to support the new project, thereby reducing the time required to complete a Call for Members process.
- The project scope can be limited to a literature review or information gathering via survey and will not face the same barriers the ROVER III project team did related to the logistics of data collection in the field.

The ROVER III project team did not undertake an in-depth scoping exercise for this work and cannot provide an estimate of budget requirements. This task could be completed using resources available through the CASA staff and in-kind support from project team members, but if funding was made available it could increase the amount and type of data gathered. For example, a literature review completed by a consultant will likely be more thorough than one completed by the project team. Funding could also allow for different types of data collection, such as a phone or digital survey of mechanics about tampering-related services they provide.

Data collection through inspection of vehicles that have excessive emissions to determine if and how emission control systems have been defeated would be the most direct mechanism to gather the desired information for this work. Unfortunately, there are significant barriers to such a study, including the financial and legal considerations involved in collecting this type of data, along with the time requirements to plan, implement, and analyze the data. Because of these barriers, the project team has not recommended data collection via vehicle inspection, but it does recognize the valuable information that could be gained if it were feasible.

Performance Evaluation

A project charter and initiation of a project team to complete this work should be approved by the CASA board during the December 2024 board meeting. The project team should begin work soon after, with final deliverables ready for decision at the December 2025 board meeting.

Recommendation 4:

Identify Actions and Initiatives to Reduce Vehicle Tampering

The GoA, upon receipt of the comprehensive study report on emissions controls and tampering in Alberta (recommendation 3), should identify actions and initiatives as needed to address the findings of the study, and assess how their implementation could support and further any existing work in this area. This assessment would include determining the key measures and corresponding monitoring and reporting mechanisms required to track the progress and validate the success of identified actions and initiatives.

Rationale

It is CASA's belief that additional actions and initiatives by the Government of Alberta may be required to have a significant impact on vehicular emissions in Alberta. There may be voluntary changes in behaviour, but for cases where tampering or lack of maintenance on emission control systems is identified as an issue, real progress will not occur without government leadership. Data comparisons with California and Oregon, jurisdictions which have anti-tampering legislation, show that average emissions for vehicles registered in Alberta are greater. This difference may be influenced by multiple factors, such as non-regulatory programs aimed at reducing vehicle emissions, but it is believed that dedicated programs or policies such as anti-tampering legislation are driving the lower emissions in California and Oregon.

Implementation Considerations

The project work included a review of programs and actions undertaken in other jurisdictions that support reducing rates of tampering with emissions control systems. These actions included, but were not limited to:

- Including emission control equipment in vehicle safety inspections, both through a visual check and by using appropriate measurement methods to determine if the emission control systems have been defeated.
- Emissions testing as a requirement for vehicle registration (e.g., the DriveON program in Ontario[23]).
- Inspection and maintenance programs that require an annual scan of onboard diagnostic equipment data, or a smoke opacity test and visual inspection, depending on the vehicle's model year (e.g., the California Air Resources Board Clean Truck Check program).
- Appropriate regulatory tools and government support to enable government enforcement action against manufacturers, sellers, and installers of emission control defeat devices into the Alberta market.
- Fines or revocation of vehicle registration for violation of regulations or policies related to tampering with emission control systems.

This project did not include a feasibility assessment for which programs or actions would be appropriate for implementation in Alberta, and CASA recognizes that measures aimed at reducing rates of tampering with vehicle emission controls can have varying structures or supports needed for implementation. For example, including emission control equipment in vehicle safety inspections would require personnel to complete training on recognizing different methods of tampering and defeat devices. However, actions undertaken in other jurisdictions could provide guidance for how programs could be implemented in Alberta.

Support from other stakeholders, such as using existing communication channels to reach the target audience for these actions, will be necessary for their success.

Performance Evaluation

CASA acknowledges that identifying actions to address high vehicle emissions will require collaboration between multiple GoA ministries. While the status of this recommendation can be assessed annually as part of CASA's recommendation tracking process, an expected timeframe for completion of this recommendation was not identified.

However, Recommendation 1: Undertake a future On-Road In-Use Vehicle Emissions Testing Study (ROVER IV) can be used to help assess effectiveness of any implemented actions to address high emissions from the transportation sector. CASA has recommended that data collection for ROVER IV not begin before 2029 to allow time for any identified actions to be implemented and affect results.

23 https://www.ontario.ca/page/driveon-emissions-and-safety-inspection-program

Recommendation 5A:

Increase Public Awareness and Education on Emissions Control Technology

CASA should work with appropriate stakeholders to plan and implement an awareness and education campaign targeted at the public on the impacts that excess emissions caused by malfunctioning emission control systems may have on air quality and health.

Recommendation 5B:

Increase Heavy-Duty Vehicle Owner and Operator Awareness and Education on Emissions Control Technology

CASA should work with appropriate stakeholders to plan and implement an awareness and education campaign targeted at HDV operators and owners to increase awareness and education on improvements in emission control technology (e.g., operation and maintenance costs), and issues related to tampering and maintenance.

Rationale

Targeted campaigns to educate and increase awareness on the impacts of tampering with emission control systems or not performing required maintenance can be implemented quickly and can help reduce emissions from the transportation sector through voluntary action by the intended audiences. Tampering, if driven by incorrect perceptions or misconceptions of increased vehicle performance due to defeated emission control systems, could be reduced by a well-planned and executed education and awareness campaign that encourages behaviour change by dispelling these misconceptions.

Implementation Considerations

Based on the draft CASA's 2023–2027 Strategic Plan, there is a role for CASA in air literacy and this recommendation would benefit from a multi-stakeholder approach. CASA's role in this campaign would be as follows:

- Develop key messages.
- Identify appropriate audiences.
- Identify and engage with partners who can reach the targeted audiences through existing communication channels.
- Work with partners to disseminate the key messages using appropriate formats and platforms.

Elements that should be considered for the campaigns are summarized below, including further details on the specific messages, audiences, and potential partners.

Public Education and Awareness Campaign

An education and awareness campaign directed toward the public should include stakeholders such as Airshed Organizations, municipalities, the GoA, the Federal Government (e.g., Natural Resources Canada, Environment and Climate Change Canada), and the Alberta Motor Association in the planning, development, and delivery stages.

Development of key messages should consider information from existing programs aimed at reducing emissions from personal vehicles (e.g., anti-idling campaigns), and from programs used in other jurisdictions (e.g., Check Engine Light Awareness campaigns). In addition, the following topics should be included:

- What tampering is, including altering existing emission control technologies on vehicles or installing equipment that interferes with those controls.
- Air quality, the health impacts of vehicle exhaust, and how both are connected to tampering with emission control systems.
- Dispelling misconceptions related to emission control technologies and tampering.
- Recommended maintenance schedules to ensure emission control systems are functioning correctly and potential impacts if the maintenance is not performed.

While the link between transportation emissions and health is well-established,[24,25,26] the degree of health impact from excess emissions due to tampering or lack of maintenance of emission controls was not explored in this project, and it needs further study.

The planning process for this campaign should leverage existing channels used by drivers to share messaging to improve reach and uptake (e.g., Alberta Motor Association New Driver Program or Learners Handbook, Edmonton Police Service's work to combat catalytic converter theft).

24 https://www.canada.ca/en/health-canada/services/publications/healthy-living/health-impacts-traffic-related-air-pollution.html
25 https://www.canada.ca/en/health-canada/services/publications/healthy-living/human-health-risk-assessment-gasoline-exhaust-summary.html
26 https://www.canada.ca/en/health-canada/services/publications/healthy-living/human-health-risk-assessment-diesel-exhaust-summary.html

Heavy-Duty Vehicle Owner and Operator Education and Awareness Campaign

Key stakeholders for an education and awareness campaign directed toward commercial fleet owners and operators include the stakeholders identified for the public campaign, as well as fleet operators, trucking and driving associations (e.g., AMTA, Canadian Trucking Alliance, Alberta Motor Association), and industry associations (e.g., Canadian Fuels Association, Chemistry Industry Association of Canada, Canadian Association of Petroleum Producers, Team Alberta, Alberta Sand and Gravel Association, and others) in the planning, development, and delivery of appropriate messaging.

Messaging for this campaign should include:

- Information on the specific activities being targeted (e.g., manufacturing, selling, or installing equipment that interferes with vehicle emission controls).
- Improvements in emission control technology operations and maintenance.
- Available incentive programs for fleet emissions reductions.
- Information targeted at the myths and perceptions about tampering and emission control systems:
    - *Reliability and engine life:* The belief that emission control systems can introduce additional wear and strain on engines and therefore reduce engine life.
    - *Vehicle performance:* The belief that overriding manufacturer engine control units can improve engine performance through increased horsepower ratings or higher fuel injection pressures.
    - *Cold climate impacts:* The belief that emission control systems are not effective at very low temperatures, resulting in increased costs and fuel consumption without the accompanying emissions benefits.
- Information targeted at the motivations for emission control system tampering, for example:
    - *Operational cost savings:* Deactivation or removal of selective catalytic reduction (SCR) systems or particulate filters removes costs associated with their maintenance.
    - *Decreased maintenance and downtime:* Particulate filters and SCR systems require regular maintenance to remain effective.
    - *Decreased fuel consumption:* Emission control systems can reduce fuel economy and therefore increase operating costs.
    - *Competitiveness:* Emission control systems introduce restraints that are not shared by fleet operators and private operators who tamper with their vehicles, giving them a competitive advantage.
    - *Vehicle customization:* Vehicle owners modify their vehicles for a variety of reasons, including as a hobby or for perceived status or recognition.

Where possible, the planning committee should utilize existing sources of information for dispelling myths regarding tampering, such as previously completed projects on tampering (e.g., work from ICCT and the University of Alberta and Simon Fraser University).

Where possible, the campaign materials should be disseminated using platforms that are directed toward and trusted by audiences who are more likely to tamper with emission control systems (e.g., websites like Driving[27] or Diesel Army[28], AMTA and SmartWay publications). Additional communication channels that could be used include:

- CASA's website and social media accounts.
- CASA member and partner networks (e.g., industry associations, municipalities, Airshed Organizations).
- Air quality communication organizations in Alberta, including communication channels for air quality messaging identified in other CASA projects (e.g., the IRTAQ project).
- Organizations involved in trade certification or endorsement (e.g., Alberta Trade Secrets, the Red Seal Program).
- Driving and trucking association websites, social media, or publications (e.g., newsletters).
- The group undertaking the planning and development of the campaign could also consider online advertising services to provide targeted information to specific audiences.

27 https://driving.ca/column/corner-wrench/your-corner-wrench-why-you-shouldnt-bypass-your-diesels-emissions-controls
28 https://www.dieselarmy.com/features/editorials-opinions/why-you-should-not-emissions-delete-your-diesel-truck/

Performance Evaluation

Six months following the education and awareness campaign implementation, and on an annual basis thereafter, the following should be assessed:

- The number of times communications materials have been accessed and downloaded from the CASA website.
- Engagement with social media posts.
- The number of times the campaign's messaging has been disseminated through partners' communication channels, and any available engagement information (e.g., page visits, downloads).

Information on transportation emissions obtained through Recommendation 1: Undertake a Future On-Road In-Use Vehicle Emissions Testing Study (ROVER IV), could help support assessment of the effectiveness of the education and awareness campaigns.

Recommendation 6:

Provide Incentives for Existing High Emitters to Lower Their Emissions

Organizations, businesses, or other groups that procure the services of transportation carriers should consider requesting information from proponents on the maintenance history of their vehicles and membership in programs that promote safety, fuel efficiency, or other sustainable practices (e.g., SmartWay, SmartWay Affiliates, Partners in Compliance, Michelin's GreenerFleets), and favour proponents who meet those criteria.

Rationale

A key factor driving HDV owners and operators to either tamper with or not maintain emission control systems are the real or perceived financial benefits for doing so. If efforts targeting these high emitters are to be successful, they must consider financial implications and where possible, provide financial incentives for improving vehicle emissions rather than increasing operational costs. However, a large challenge for establishing and maintaining incentive programs is the need for sustainable long-term funding.

One method to provide financial incentives for HDV owners and operators without requiring a long-term funding source is for routine maintenance and membership in programs that promote safety, fuel efficiency, or other sustainable practices to favourably impact procurement.

This recommendation represents both support for and an expansion of a recommendation previously made through CASA's NPS Project:

Recommendation 6: That Alberta Environment and Parks and Alberta Transportation work with appropriate stakeholders to:

i. Provide education and promotion of commercial freight membership in the SmartWay Transport Partnership.

ii. Encourage, through the SmartWay Transport Partnership, increasing fleet fuel efficiencies through education and promotion of the use of fuel efficiency technologies, such as aerodynamic devices, idle reduction devices, or low rolling resistance tires.

iii. Encourage SmartWay participation as a consideration for procurement.

Implementation Considerations

Any organization, business, or group that procures the services of transportation carriers in the province should consider implementing this recommendation. Those groups include, but are not limited to:

- federal, provincial, and municipal governments
- school districts
- businesses requiring transportation of freight that do not maintain a private fleet (e.g., within municipalities or within the province)
- construction companies
- agricultural operations (e.g., cattle liners, grain haulers)

While this recommendation's intent is to target high emitters to encourage more environmentally friendly practices, a more direct approach would involve carriers providing emissions data for their fleets. But, as emissions testing is not required for HDVs, this information is not currently available for consideration and is not included in the recommendation. If, at some point in the future, emissions testing is incorporated into processes such as safety inspections or as a requirement for vehicle registration, emissions data should also be considered in procurement processes.

CASA acknowledges that changes to evaluation criteria for procurement processes can be both administratively complex and can have far-reaching implications beyond the intended result of encouraging carriers to complete routine maintenance and participate in programs that support fuel efficiency, safety, and sustainable practices,

and as a result it may not be feasible for all organizations to change procurement criteria.

Other procurement-related methods to incentivize carriers to conduct routine maintenance and participate in transportation-related environmental programs is for the hiring company or organization to use social media, newsletters, or other communication channels to promote carriers who have demonstrated these practices, thereby increasing brand awareness and credibility for the carrier.

Performance Evaluation

Some of CASA's member organizations and partners routinely hire transportation fleets for their operations. Beginning in 2025, CASA's annual recommendation tracking process should include updates from these sectors and partners on whether they have considered routine maintenance and participation in transportation-related environmental programs in their hiring decisions.

Recommendation 7:

Communicate on Transportation-Related Projects and Support Collaboration Opportunities

CASA should work with other stakeholders to plan and implement a webinar or webinar series to support air literacy and promote collaboration on work related to the transportation sector and its link to air quality.

Rationale

The third goal of CASA's 2023–2027 Strategic Plan is to build capacity for the collaborative approach to managing air quality in Alberta through strengthening partnerships and networks and improving air literacy for its members and other interested groups. This recommendation aligns with that goal and will help build awareness and understanding of the transportation sector and its impact on air quality.

A significant volume of work has been completed or is currently underway on management of emissions from the transportation sector, and a webinar or webinar series is a useful platform to share information on the work with a broader audience and identify opportunities for partnerships or synergies, and to help reduce any duplication of effort.

Implementation Considerations

During this project, the ROVER III Communications Subgroup explored the level of interest in a webinar or webinar series including the results from the ROVER III project, and identified the following groups at a minimum who should be engaged in planning:

- CASA members involved with the transportation-related project teams (e.g., ROVER III, IRTAQ, CAAQS)
- ICCT
- Opus
- academic institutions (e.g., University of Alberta and Simon Fraser University)
- Airshed Organizations
- AMTA

The webinar(s) should be developed with the following goals in mind:

1. Increasing knowledge on the transportation sector, existing or planned federal, provincial, and municipal regulations and practices related to transportation emissions, activities by other groups in the transportation emission space, and the impacts of emissions from the transportation sector on air quality and human health.
2. Sharing information on recently completed and ongoing projects or actions related to transportation emissions management.
3. Identifying actions to help manage emissions from the transportation sector.
4. Identifying opportunities for collaboration (e.g., roles of support or lead).

The group planning the webinar(s) should consider the following target audiences and tailor messaging accordingly:

- CASA members and partners
- federal, provincial, and municipal governments
- transportation-related industry groups (e.g., Canadian Trucking Alliance)
- news outlets or other communication channels targeted at vehicle performance and maintenance (e.g., Truck News, Diesel Army)
- environmental organizations
- academic institutions
- other groups or people involved with decision-making in relation to transportation and transportation emissions management
- the public

The webinar(s) should have a page on CASA's website that includes a recording of the webinar(s), any available project reports, and any communication tools for the projects.

Performance Evaluation

After the webinar(s) has been completed, the following information should be gathered:

- number of attendees
- number of sectors represented
- engagement with CASA's website (e.g., the number of views or downloads of webinar materials)
- number of times webinar recordings have been shared, if the information is available (e.g., through a self-reporting process when the recording is accessed or downloaded)
- participant responses to a post-webinar questionnaire to evaluate the webinar's effectiveness

Recommendation 8:

Use the Results of the ROVER III Project to Update Modelled Incidence and Impacts of Tampering in Canada

The ICCT should update the model inputs used for the Heavy-Duty Emissions Control Tampering in Canada report with the emissions data collected through the ROVER III project and re-run the model.

Rationale

In 2022, the ICCT released a report[29] that included a holistic assessment of the issues that motivate and facilitate tampering with emission control systems on HDVs and modelled impacts of tampering on air quality and health impacts in Canada. The modelling inputs and scenarios used the best-available information at the time, but there was a lack of concentrated studies on the effect and prevalence of tampering for HDVs in Canada; ICCT utilized insights from the U.S. Environmental Protection Agency (U.S. EPA) report, Tampered Diesel Pickup Trucks[30] to fill this gap.

ICCT was identified in CASA's agreement with Service Alberta as an organization that could receive and use the de-identified dataset containing both the emissions data and vehicle characteristic information collected during ROVER III. Unfortunately, the dataset was not available for ICCT's use when they were completing their tampering study. While the ROVER III dataset is not direct evidence of tampering as the data collection campaign did not include vehicle inspections to confirm the reason(s) for high emissions, these data and any new information could help inform an updated study.

Implementation Considerations

CASA recognizes that a significant barrier to completing this work is funding. A partnership with CASA and its networks, including academic institutions (e.g., University of Alberta, Simon Fraser University), to undertake the work could support greater funding opportunities through grant programs in Canada, or in-kind and financial contributions from CASA's members and their networks. Examples of grant programs that could be applicable to this work include:

- Environment and Climate Change Canada's funding programs
- National Sciences and Engineering Research Council of Canada (NSERC) Alliance Grants
- Mathematics of Information Technology and Complex Systems (Mitacs) Grants

Performance Evaluation

ICCT should provide updates to CASA on progress toward initiating the work, and once it is initiated, status updates (e.g., briefing notes, presentations) can be provided to the CASA board at board meetings.

29 https://theicct.org/publication/hdv-emissions-tampering-can-mar22/
30 https://www.epa.gov/sites/default/files/2021-01/documents/epaaedletterreportontampereddieselpickups.pdf

8 Other Issues and Perspectives

The commentary in this section reflects the views of some sector groups and does not have consensus agreement from all CASA members. The material is presented to reflect some of the interests on these matters and the scope of the project team's discussion.

During the process of developing the consensus recommendations in Section 7, the project team discussed a range of options for management actions. A significant area of discussion which did not result in a consensus recommendation was the need for a policy or regulatory framework to address higher vehicle emissions, both federally and provincially. This section provides some information on the issue and the project team's discussions.

8.1 FEDERAL ANTI-TAMPERING LEGISLATION

The *Canadian Environmental Protection Act*, 1999 (CEPA) contributes to sustainable development through pollution prevention and provides the legislative basis for a range of federal environmental and health protection programs, including emissions from industrial and commercial transportation sources. Part 7 Division 5 of CEPA effectively enables the federal government to prohibit the incorporation of defeat devices on new vehicles and engines that are manufactured in Canada and vehicles imported into Canada. In 2016, the Standing Committee on Environment and Sustainable Development initiated a review of CEPA. The report[31] was released in 2017 and contained 87 recommendations. Recommendation 69 from the report is:

> *The Committee recommends that CEPA be amended to empower Environment and Climate Change Canada to take action against anyone who manufactures, sells, or installs equipment that interferes with vehicle emission controls.*

Amendments to CEPA received Royal Assent in June 2023, but recommendation 69 was not included in the amendments to CEPA that were passed.

In 2022, ICCT published a study[32] that provides a holistic assessment of the issues that facilitate emission control system tampering in HDVs in Canada and estimates the impacts of tampering on emissions inventories and public health. ICCT reported that public policy can have a crucial role in avoiding detrimental consequences to air emissions and health from tampering and recommended that Canada should explicitly prohibit tampering at the federal level.

8.1.1 Summary of Project Team Discussions

The project team reviewed the above-mentioned reports and discussed them in the context of the gap in federal legislation relating to anti-tampering. They considered a recommendation aimed at the Government of Canada to mirror and reinforce recommendation 69 made by the Standing Committee on Environment and Sustainable Development in 2017 in the context of federal policy.

Enforcement methods to improve compliance were a key part of the discussion. Enforcement methods used by the U.S. EPA were considered for application in Canada. In the United States, the *Clean Air Act* explicitly prohibits people from removing or defeating emission control systems and the manufacture and sale of defeat devices. Violations of the Act are enforced by the U.S. EPA, and fines can be substantial. For each act of tampering, manufacturers and dealers can be fined up to $48,192 US, and individuals can be fined up to $4,819 US. The U.S. EPA has enacted these fines for companies and individuals in the United States, and for businesses in other countries which were found to be supplying defeat devices for use in the U.S. For example, in 2022 the U.S. EPA fined a company based in Red Deer, Alberta, $1.6 million US for manufacturing and selling defeat devices in the United States.

8.1.2 Areas of Consensus and Non-consensus

The potential recommendation was not supported by all sectors, and therefore was not included in Section 7 of this report. The primary issue that could not be reconciled was related to concerns around the jurisdictions of the federal and provincial governments.

Several sectors supported a recommendation aimed at the federal government on the basis that, to date, Alberta has not pursued related policy, and recommendations aimed at the federal and provincial governments strengthen the recommendation package by addressing known gaps at both levels.

Sectors that did not support the recommendation had jurisdictional concerns around federal and provincial government responsibilities. Enforcement against

31 https://www.ourcommons.ca/DocumentViewer/en/42-1/ENVI/report-8/
32 https://theicct.org/wp-content/uploads/2022/03/hdv-emissions-tampering-can-mar22.pdf

individual Albertans or Alberta-based companies, and potentially other provinces, could be problematic; instead, the sectors supported an approach directed at the provincial government's jurisdiction to address the gap.

8.2 PROVINCIAL ANTI-TAMPERING POLICY OR REGULATION

As noted in Section 8.1, there is no explicit prohibition of tampering at a federal level in Canada, so legislation or regulations prohibiting tampering fall under provincial jurisdiction. The GoA does not currently have legislation, regulations, or policies aimed at preventing tampering or prohibiting the manufacture, sale, or installation of emission control defeat devices.

While Alberta's Commercial Vehicle Inspection Program requires safety inspections for vehicles exceeding 11,794 kilograms, this inspection does not include emission control equipment. Alberta's *Traffic Safety Act* also does not prohibit tampering with emission control systems.

CASA has made several recommendations related to this issue. The ROVER I (1998) and NPS (2017) projects both recommended the GoA establish or amend provincial legislation to prohibit tampering. The NPS project also recommended that emission control systems be included in the annual safety inspections required by the Commercial Vehicle Inspection Program. While there may have been discussions on the issues related to these recommendations within the GoA, CASA has not received any formal update on the status of these recommendations or their implementation.

In Canada, Alberta, Manitoba, the Northwest Territories, and Nunavut are the only provinces and territories without explicit anti-tampering legislation or regulation.[33]

8.2.1 Summary of Project Team Discussions

Early in the development of recommendations for potential management actions, the project team began considering a recommendation directed at the provincial government. The draft recommendation went through an iterative process that eventually resulted in recommendations three and four of this report.

Several topics related to this issue were raised and discussed at length by the project team:

- Whether voluntary action could achieve results in the absence of mandatory measures such as legislation, regulation, or policy.
- The impacts of mandatory measures being on a go-forward basis, and the resulting gap in older model year vehicles that had already been tampered with.
- Enforcement and compliance programs used in other jurisdictions and their applicability to Alberta.

Ultimately, recommendations three and four were approved via consensus and are presented in this report.

8.2.2 Areas of Consensus and Non-consensus

While CASA has put forward recommendations three and four, and they received consensus support, there were areas of the discussion that did not have a consensus resolution and were not included in the final recommendation.

Initially, proposed wording involved establishment of anti-tampering legislation, which was consistent with previous CASA recommendations in this area. Over time and through considerable discussion, this wording was eventually changed to "actions and initiatives" to reduce tampering. Some sectors feel this move away from a direct reference to legislation or a policy or regulatory framework results in a less effective recommendation, as mandatory measures that are monitored for compliance and have associated enforcement methods are necessary to see a significant reduction in tampering.

These sectors believe that while the current iteration of recommendations three and four are beneficial, they do not address the existing gap of provincial-level prohibition of tampering or the manufacture, sale, or installation of defeat devices.

Additionally, the current iteration of the recommendations focuses on identification of actions and initiatives but does not directly include implementation. Some sectors expressed concern that a lack of focus on implementation is indicative that the recommendations may not result in concrete action to reduce vehicle emissions. Other viewpoints were that it is necessary to first ensure actions or initiatives resulting from this work align with any planned or ongoing work aimed at reducing high vehicle emissions before considering implementation, and that recommendations three and four represent the first steps of an incremental approach toward managing vehicle emissions.

33 Table 1: *Anti-tampering legislation in each Canadian province or territory (ordered by population)* from https://theicct.org/wp-content/uploads/2022/03/hdv-emissions-tampering-can-mar22.pdf

9 Communications

CASA has developed a communication strategy for implementation once the project is complete, and shared information on the project and the data analysis results where possible.

9.1 COMMUNICATIONS STRATEGY

The communications strategy helps guide communication of the project and its outcomes once the work has been completed. The strategy considers target audiences, key messages, tools, and recommends making use of both CASA's and its partners' networks to share information.

Communication tools developed to support the communication strategy include:

- A factsheet to provide an overview of CASA, its consensus process, the ROVER III project's scope and key findings, and the recommendations.
- A short information video on the project and its outcomes.
- A template presentation about ROVER III for CASA members and partners to use when sharing information about the project with their networks.
- A message map to support CASA's partners in communicating about this work.

CASA's website will be used to host all project documentation, while some project materials (e.g., factsheet, project video), will be shared via social media.

The communications strategy can be found in Appendix E.

9.2 INFORMATION SHARING

Throughout the project, CASA has shared information on this work where possible. In addition to providing information presentations to the CASA board at various project milestones,[34] CASA staff and project team members attended meetings and provided information on the ROVER III project for the following groups and events:

- Alberta Capital Airshed Clean Air Webinar
- Air and Waste Management Association Canadian Prairie and Northern Section Luncheon
- Air and Waste Management Association Annual Conference and Exhibition 2024
- Capital Region Air Quality Management Framework Implementation Oversight Advisory Committee
- West Central Airshed Society Community Committee

Information on the ROVER III project has also been shared at conferences by CASA's partners, including:

- Canadian Society for Mechanical Engineering International Congress (2022)
- Community Modeling and Analysis System (CMAS) Conference (2023)
- Inspection/Maintenance Solutions Training Forum for Jurisdictions (2024)
- Coordinating Research Council Mobile Source Air Toxics (MSAT) Workshop (2024)

There were also several media requests related to the data collection campaign itself, and several articles were published. Some of these articles include:

- Vehicle Exhaust in Edmonton and Four Alberta Cities Monitored as Part of a Study on Air Pollution (CTV News Edmonton, August 2021)
- Emissions Project Monitoring Pollution on Alberta Roads (Lethbridge Herald, July 2022)
- Clean Air Strategic Alliance Aims to Find Out what Trucks are Emitting (Taproot Edmonton, July 2022)

CASA will continue to share information on this work with its members and partners, and at appropriate conferences and other events, as well as strive to make the project's results available to all Albertans.

9.3 ROVER III CONTRIBUTIONS TO OTHER WORK

CASA strives to support scientific advancement on air quality, and the data collected through this project has already been used to support other initiatives.

CASA provided a letter of support and has shared the ROVER III dataset with the University of Alberta and Simon Fraser University for a study aimed at filling a knowledge gap on real-world energy consumption, GHG emissions, and criteria and non-criteria air contaminants for transportation technologies and processes in cold climate cities or under extreme weather events.

The data collected was also provided to ICCT, which aims to empower policymakers and others worldwide to improve the environmental performance of road, marine, and air transportation to benefit public health and mitigate climate change.

34 https://www.youtube.com/watch?v=g9IJv_1xjZo

10 Conclusion

The results of this work support the need for management actions to help address emissions from the on-road in-use transportation fleet in Alberta, with the focus being on HDVs. A significant proportion of the HDV fleet is emitting at least 10 times what is expected based on emissions standards for NO_x and PM, and these are pollutants of concern where Alberta is approaching thresholds for air quality standards and objectives. Though this project did not include inspection of vehicles with higher-than-expected emissions to discern the cause, it can be inferred that the emission control systems on these vehicles are either malfunctioning or have been tampered with.

Reducing emissions from transportation-related sources will require additional actions and initiatives by the government and from all sectors and groups involved in the transportation industry, along with support from Albertans as a whole. This project represents a continuation of years of transportation-related projects completed through CASA, but more work is needed. CASA will continue to support work in this area through its own projects and through supporting other organizations who are working to improve air quality through management of transportation-related emissions.

APPENDICES

Appendix A – Acknowledgements

CASA acknowledges the contributions of the following working group and project team members and participants who volunteered their time and expertise on this project, along with their member organizations for supporting their participation.

Name	Organization
Randy Angle	Prairie Acid Rain Coalition
Ann Baran	Southern Alberta Group for the Environment
Andrew Barnes	Alberta Motor Transport Association
Elizabeth Bell	Peace Airshed Zone Association
Wendy Birch	Alberta Environment and Protected Areas
Melissa Brown	City of Edmonton
Tim Dallmann	International Council on Clean Transportation
Kamran Faisal	City of Calgary
Rob Hoffman	Canadian Fuels Association
Curt Horning	Alberta Environment and Protected Areas
Vahid Hosseini	Simon Fraser University
Terri Johnson	Alberta Motor Transport Association
Bob Koch	University of Alberta
Rhonda Lee Curran	Alberta Environment and Protected Areas
Alex Martin	Alberta Transportation and Economic Corridors
Dianne McIsaac	Wood Buffalo Environmental Association
Sanjay Prasad	Wood Buffalo Environmental Association
Andrew Read	City of Edmonton
Rahul Shrivastava	Alberta Transportation and Economic Corridors
Peter Thomas	Alberta Transportation and Economic Corridors
Kevin Warren	Alberta Airsheds Council
Ruth Yanor	Mewassin Community Council

Project Managers: Katie Duffett, Lauren Hall, Cara McInnis, Jacqueline Noga, Mariem Oloroso

Appendix B – Project Charter

ROVER III Project: On-Road Vehicle Emissions Testing Study and Path Forward

Project Charter

Approved by the CASA Board December 2021
Amended April 2024

ROVER III Project Charter

APPENDIX B CONTENTS

LIST OF TABLES

Introduction

The Government of Alberta has committed to implementing the Canadian Ambient Air Quality Standards (CAAQS) as part of the national Air Quality Management System. Air emissions need to be managed for Alberta to achieve the CAAQS as they become more stringent over time.

In particular, careful management of emissions of nitrogen oxides (NO_x) will be needed and the Clean Air Strategy highlights the need for management actions on non-point sources of air emissions, such as transportation emissions. Based on the 2014 Air Pollutant Emissions Inventory, the transportation sector is one of the largest sources of NO_x emissions in the province, second only to industrial emissions and contributing approximately 30% of total NO_x emissions. The transportation sector is provincewide. In addition to emitting NO_x and other air contaminants with associated health impacts, the transportation sector is a notable emitter of greenhouse gases.

The Government of Alberta, led by Alberta Environment and Parks (now Alberta Environment and Protected Areas) identified an opportunity for a CASA Project Team to support CAAQS implementation and general air quality management. This work will involve an on-road vehicle emissions testing study to gather information on in-use vehicle emissions, and inform next steps for vehicle emission reductions, while leveraging existing communication channels for messaging on vehicle emissions and their impact on air quality. This project can also support alignment of provincial initiatives with the intent of federal legislation to reduce both air and greenhouse gas emissions from vehicles.

This project charter outlines the work as well as its suitability to the CASA process.

Background

The CASA Project on Non-Point Sources (2015–2017) was tasked with helping to address non-point source air emissions contributing to ambient fine particulate matter ($PM_{2.5}$) and ozone (O_3) standard non-achievement in Alberta, and had a large focus on the transportation sector. This project charter was informed by draft recommendations from that project.

Based on the 2014 Air Pollutant Emissions Inventory, the on-road transportation sector is a large emission source of NO_x (particularly heavy-duty diesel vehicles, followed by light-duty gasoline trucks and other vehicles), a source of volatile organic compounds or VOCs (particularly light-duty gasoline trucks and other vehicles), and a source of primary $PM_{2.5}$ (particularly heavy-duty diesel vehicles). In 2012, the International Agency for Research on Cancer (IARC) classified diesel engine exhaust as carcinogenic to humans based on evidence that exposure is associated with an increased risk for lung cancer.[35] More recently, Health Canada published a document that categorizes the relationship between lung cancer and diesel exhaust as causal based on a weight-of-evidence analysis of epidemiological data as well as identifying a suggestive relationship between bladder cancer and diesel exhaust.[36]

An innovative on-road vehicle emissions testing study could help: 1) characterize emissions from in-use vehicles (e.g., determine which ages and classes of vehicles have the highest and lowest emissions and whether emissions reality matches perception) in a particular area, such as within the Edmonton to Calgary corridor or other, 2) identify potential impacts of program and policy options (e.g., design to target highest emitters), and 3) test the feasibility of integrating emissions testing into program options (e.g., for identifying high emitters). In addition to data gathering, this would also be an ideal opportunity for education/awareness on vehicle emissions and their impact on air quality.

A similar, short-term study was conducted in British Columbia in 2012,[37] where emissions data for nitric oxide, particulate matter, hydrocarbons, carbon monoxide,

35 Reference: International Agency for Research on Cancer. (2014). Diesel and Gasoline Engine Exhausts and Some Nitroarenes / IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. [PDF, ISBN 978 92 832 01434, ISSN 1017-1606] Lyons, France: International Agency for Research on Cancer, pp. 39–484. Available at: http://monographs.iarc.fr/ENG/Monographs/vol105/mono105.pdf [Accessed 13 Dec. 2017].

36 Government of Canada. (2016). Human Health Risk Assessment for Diesel Exhaust. [PDF, Cat.: H129-60/2016E-PDF, ISBN: 978-0-660-04555-9, Pub.: 150239] Ottawa, Ontario: Health Canada, pp. 1–38. Available at: http://publications.gc.ca/collections/collection_2016/sc-hc/H129-60-2016-eng.pdf [Accessed 13 Dec. 2017].

37 Reference: Greater Vancouver Regional District Remote Sensing Device (RSD) Trial for Monitoring Heavy-duty Vehicle Emissions, Envirotest Canada, March 2013.

and carbon dioxide were collected for a variety of diesel vehicles and model years using a remote sensing device (RSD) system and a heavy-duty emissions tunnel (HDET). These newer technologies provide data beyond the snap acceleration smoke test, used for tailpipe testing, which has limitations for measuring particulate matter and does not measure NO_x.

Furthermore, the earlier ROVER (Roadside Optical Vehicle Emissions Reporter) I and ROVER II projects were completed in Alberta through CASA. In 1998, the ROVER project assessed actual in-use vehicle emissions using a remote sensing van equipped to measure exhaust emissions, including carbon monoxide. It also communicated with Albertans about vehicle emissions. During ROVER I, over 42,000 light-duty vehicles were tested in four municipalities. In 2006 the project was repeated as ROVER II, testing over 66,000 vehicles in Edmonton, Calgary, Red Deer, and Canmore. This time the team measured exhaust emissions of nitric oxide, particulate matter, hydrocarbons, carbon monoxide, and carbon dioxide. ROVER II found emissions per kilometre were falling but vehicle use was increasing. Furthermore, the results indicated that although the number of higher emitters was relatively small at 5%, they contributed a larger proportion of emissions (60% of carbon monoxide, 31% of hydrocarbons, 26% of nitric oxide, and 7% of particulate matter).

At the CASA Board meeting on September 30, 2010, in advance of the renewed Clean Air Strategy, the Board reviewed the CASA Vehicle Emissions Team Final Report to the CASA Board and agreed upon the following consensus statements:

1. Transportation-related air emission issues continue to exist.
2. Understanding the Clean Air Strategy and its guidance will be important in developing future work on transportation emissions.
3. Stakeholders are encouraged to bring a statement of opportunity to CASA, at an appropriate time, to address these issues.

The additional step in this project includes recommending management actions and/or next steps for vehicle emission reductions, such as for highest emitters, which would be informed by the emissions testing study, reference material on management actions implemented in other jurisdictions, and discussions with key stakeholders.

Scope

The work of the project team will be limited to using remote sensing technology to test emissions from the in-use on-road vehicle fleet, including heavy-duty and light-duty trucks/vehicles, and making recommendations on managing emissions from the on-road transportation sector.

The focus of this work is intended to be diesel-fuelled trucks but would also collect data on other heavy-duty vehicles (e.g., buses) and light-duty vehicles (e.g., personal vehicles). The emissions of focus include NO_x, VOCs, CO, CO_2, and particulate matter for a holistic approach (selected air contaminants and greenhouse gases) but recommendations to reduce these substances is expected to have the co-benefit of reducing other emissions.

Project Goal

To measure emissions from the in-use on-road transportation sector, particularly diesel-fuelled trucks, to inform management actions and/or next steps for transportation emissions management to help achieve the CAAQS in Alberta.

Project Objectives and Strategies

The “Potential Outcomes/Deliverables” under each objective are not meant to be prescriptive or limit the creativity of the project team, rather to provide additional context around the intent of the objectives. They are meant to help inform discussions of the project team by providing an understanding of working group conversations. The project team members will create more detailed work plans which will outline how each strategy is to be executed. As they do so, specific outcomes and deliverables will be identified based on what is most appropriate and useful to achieving each objective.

OBJECTIVE 1

Compile and review information and agree on a common understanding of current transportation emissions and their management in Alberta.

Strategies

1.1 Gather and review existing and planned work on current transportation emissions and their management in Alberta and other jurisdictions.

1.2 Determine any permits or permissions required to undertake the on-road vehicle emissions testing study and the time required to obtain them.

Potential Outcomes/Deliverables

- Understanding of work being done in Alberta and elsewhere to measure and manage transportation emissions.
- Summary document: List of reference materials on similar and related work on transportation emissions and management in Alberta and other jurisdictions.

OBJECTIVE 2

Undertake an on-road vehicle emissions testing study (or studies) to gather data on emissions from in-use on-road light-duty and heavy-duty vehicles, focusing on diesel-fueled trucks.

Strategies

2.1 Define the scope of the on-road vehicle emissions testing study including the emission parameters and vehicles of focus (e.g., on-road heavy-duty diesel and/or light-duty diesel vehicles) given available funding.

2.2 Confirm availability of the potential contractor(s) and initiate a contract for the on-road vehicle emissions testing study.

2.3 With input from the consultant, outline the design of the emissions testing study including the number and location of testing sites for representativeness given available funding, the desired time periods for data collection, and how to address any limitations or risks. The testing site determination must also consider CAAQS achievement (PM, O_3, NO_2), areas where the vehicles of focus frequent (e.g., trucks and commercial buses in Fort McMurray, main travel corridors), and the locations used in previous similar studies (Calgary, Edmonton, Red Deer, and Canmore).

2.4 Obtain any necessary permits or permissions for data collection (e.g., testing site set-up authorization and selected vehicle registration information gathering).

2.2 Obtain registration information for the vehicles tested during the on-road vehicle emissions testing study from Service Alberta.

Potential Outcomes/Deliverables

Study is undertaken and data are collected for the vehicles of focus, emission parameters, and locations during the desired time period(s).

OBJECTIVE 3

Develop a vehicle emissions profile for the in-use on-road vehicle fleet based on data from Objective 2 and compare results from this and similar studies.

Strategies

3.1 Evaluate and summarize the data collected during the on-road vehicle emissions testing study to characterize the fleet. This includes identifying which model years, classes of vehicles, and fuel types are the lowest and highest emitters. If possible, this would also include comparing emissions profiles of vehicles enrolled in an appropriate program available at the time of the emissions testing study, such as the Partners in Compliance (PIC) program or the SmartWay Transportation Partnership, versus those not enrolled.

3.2 Compare results between the different ROVER III testing sites (e.g., between Fort McMurray and elsewhere) and between ROVER III and similar studies from British Columbia, Alberta, or other jurisdictions highlighting any key similarities or differences.

Potential Outcomes/Deliverables

- On-road vehicle emissions testing study report is completed and includes characterization of the fleet and highlights any key results or insights.
- Data collected provided separately to the report in a format to be decided by the contractor(s) and the project team.

OBJECTIVE 4

Evaluate and recommend management actions and/or next steps to reduce emissions from the in-use on-road vehicle fleet based on the outcomes of Objectives 1 and 3.

Strategies

4.1 Develop a list of potential management actions and/or other next steps for implementers (i.e. Governments, Airshed Organizations, etc.). Additional inputs or considerations should include:

- Input from key stakeholders;

- Considerations for socioeconomic concerns, any advantages or disadvantages to affected stakeholders, and alignment of provincial initiatives with federal legislation with the intent of reducing both air and greenhouse gas emissions from vehicles;
- Evaluation of potential management actions and/or next steps for emitters, leveraging existing available information wherever possible. Some considerations may include:
  - cost/benefit analysis
  - ease of implementation
  - feasibility of integrating emissions testing into program options (e.g., for identifying high emitters on a more ongoing basis).

Potential Outcomes/Deliverables

- Recommendations for management actions and/or next steps to help reduce emissions from the transportation sector in Alberta, that are complementary to, rather than duplicative of, initiatives that are existing or already planned.

OBJECTIVE 5

Develop and implement a strategy and action plan for communicating the work of the project team, and on vehicle emissions and their impact on air quality.

Note: Objective 5 will need to be considered at the outset and on an ongoing basis to determine what stakeholder and public engagement will be necessary and/or appropriate at each stage of the project.

Strategies

5.1 Identify existing communication channels that could be leveraged.

5.2 Determine relevant information to be communicated, the appropriate audience, timing, and how it will be communicated.

5.3 Engage stakeholders as required throughout the project.

5.4 Provide advice on stakeholder and public engagement to the implementers of management actions, where applicable.

5.5 Develop messaging on the outcomes of each objective for project team members to communicate relevant information to their constituents.

Potential Outcomes/Deliverables

- Communications strategy detailing what, how, when, and to whom project team information will be communicated.
- Message map for communicating on vehicle emissions and their impact on air quality via existing communications channels.
- Survey of selected audience(s) to inform future education/awareness activities (e.g., to gauge awareness, encourage good performers, and/or debunk any myths).

Project Deliverables

The project team will provide the following deliverables:

- Consultant report containing a description and the results of the vehicle emissions testing study, and includes comparisons of results to similar studies in Alberta and other jurisdictions and of those enrolled in the PIC program;
- Data collected during the emissions study;
- Final report that includes the project methodology, findings, outcomes, and recommendations including any advice to implementers of potential management actions and/or next steps;
- Communications strategy for dissemination of the findings and results of the project; and
- Performance measure(s).

It should be noted that *CASA's Performance Measures Strategy: A "how-to" guide to performance measurement at CASA* indicates that each project team is required to generate one specific metric that will allow the success of the team to be evaluated five years in the future. More guidance on how this can be achieved can be found in the strategy.

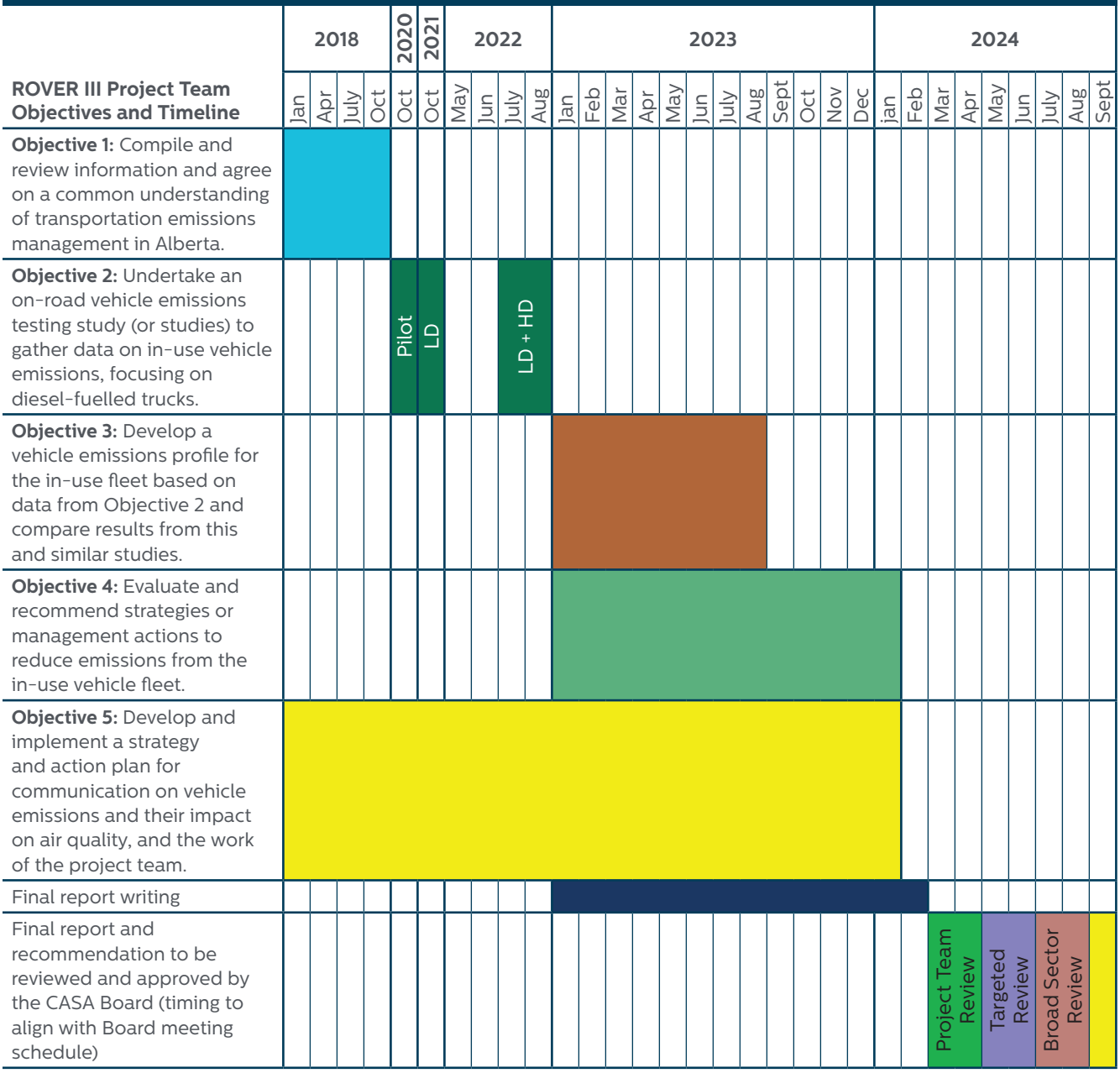
Project Structure and Schedule

Project work should begin in April 2018. The working group anticipates that the entire project may take just over six years, due to delays midway through the project, with an estimated completion date of September 2024.

The bulk of the work is sequential, meaning that the outcomes of Objective 2 are the inputs to Objective 3, and the outcomes of Objectives 1 and 3 are the inputs to Objective 4. The project team should also assess the entire process to identify opportunities for work to be done concurrently and for possible co-benefits.

Refer to Table 1 for a high-level illustration of the process and information on the time constraints related to Objective 2.

TABLE 1: ROVER III PROJECT TIMELINE*



*The overall project schedule will depend on the time required for Objective 2 which is dependent on Opus's ability to cross the border combined with the COVID-19 pandemic trajectory, and Objective 3, which is dependent on the time to obtain the vehicle registration information and is outside the control of the project team.

** The portion of Objective 2 that occurred in October 2020 was a pilot study to prepare Opus for the field season.

Projected Resources and Costs

Table 2 outlines the potential external costs over the life of the project as anticipated by the working group. These figures are estimates only. As the work of the project team progresses, detailed work plans and associated budgets will need to be created. The funds to complete this work will need to be assured prior to the commencement of the project. Note that the bulk of the funding will likely be required in implementation of Objective 2, which occurs early in the project.

The funding for Objective 2 is required upon project initiation to secure the contractor(s) and ensure they can undertake the emissions testing study as per the project schedule.

TABLE 2: ESTIMATED ROVER III PROJECT BUDGET

Item	Comments	Estimated Cost
Consultant fees to undertake Objectives 2 and 3, as follows: • Complete an on-road emissions testing study (or studies) for the vehicles of focus during the desired time period(s) • Develop a vehicle emissions profile for the in-use on-road vehicle fleet and compare results from this and similar studies	*Critical cost* requiring funding for project commencement	$150,000[a]
Fall 2020 Pilot Study (Objective 2)	Consultant value-add	$0
Fee to obtain registration data on tested vehicles from Service Alberta (Objective 2)	Fee of $15 per licence plate, waived via Ministerial Order	$0
Fee for development of input and output files required for Service Alberta registration data request (Objective 2)	*Critical cost*	$10,000
A workshop to obtain feedback on and refine management actions with interested parties (Objective 4)	Optional cost, cost may be reduced	$5,000
Development and implementation of communications strategy (Objective 5), to potentially include: • Workshop with interested parties • Survey of selected audiences • Communications materials (e.g., message map, backgrounder, etc.)	Optional cost, cost may be reduced	$5,000
Final Report Writing	Cost may be reduced	$5,000
Total Estimated External Costs		**$175,000**

[a] In-depth discussion of the project team is needed to confirm the scope of Objective 2, particularly as the costs vary by the number of testing sites and time in the field. This estimate assumes testing site locations in five municipalities (one week in the field in each municipality) and a final report including a summary of the collected data and a vehicle emissions profile. The cost associated with testing each week is approximately $25,000 and a further $25,000 is required for the consultant's report. The more testing data obtained, the more representative the study results may be of the vehicle fleet.

Risk Analysis

Identifying, analyzing and mitigating project risks is a key component of executing a successful project. The project team should incorporate proactive risk management into the project to mitigate risks that could undermine its success.

Table 3 lists the risks as well as possible mitigation strategies identified by the working group that the project team should consider as they undertake their work.

TABLE 3: ROVER III RISK ANALYSIS INCLUDING POSSIBLE MITIGATION STRATEGIES

Risks	Possible Mitigation Strategies
Process	
Timely funding not available	• Identify who the "customers" of this work are. Who will find this valuable – seek funding there • Develop a strong value-proposition that includes: examples of sectors that may be involved or affected • Project team members discuss the work and associated need for funding with their constituents early in the process
Recommended management actions are too broad or not specific to the project goal	• Seek a balance between regional needs and provincial applicability in management actions chosen • Consider prioritizing cross-cutting actions that provide regional benefit and have the potential to be broadly applicable • Consider ways to align this work with existing management frameworks and plans
Can't reach agreement, e.g., on testing study design, management actions, or communications	• Determine in advance which pieces of work do and do not require consensus • Outline a clear decision-making process that includes what happens if the team can't agree – who will make the decision? • Have an explicit discussion around Interest-Based Negotiation, and get all the interests of the team members on the table
Project Team doesn't understand or follow the Project Charter	• Working group to create a project charter that is clear, especially with respect to the intent for sequencing of objectives • Board receives regular updates to ensure progress is monitored
CASA Board doesn't agree with management actions identified in Objective 4	• Project team members liaise with their constituents and Board members on an ongoing basis • Project team provides regular status reports for Board meetings
Recommendations of the project team are not implemented. Specifically, advice given on implementing management actions in Objective 4	• This risk is outside the scope of the project team to mitigate; however, this risk will be reduced if: i) the parties potentially involved in implementation are engaged, and ii) reference to implementation (who and how) is included in the report's recommendations
Information Collection	
Permits for data collection are not obtained in a timely manner and cause project delays	• Municipal representatives are involved early in the project and can inform the project team of the required permits and timelines for acquisition to ensure they are obtained prior to the data collection window • Similarly engage Service Alberta regarding access to vehicle registration information for vehicles registered in the province
Consultant is not available during the project data collection window	• Engage the consultant as far in advance as possible to ensure availability (e.g., once project charter is approved by the CASA Board)

Lack of/limited information (accessibility)	• Ensure project team membership enables the team access to information • Use judgment where information is unavailable
Privacy concerns potentially impacting the ability to collect vehicle registration data and use limitations cause project delays or impact the study results	• Determine requirements and data use limitations for vehicle registration data early in the project (e.g., once project charter is approved by the CASA Board)
Technology limitations (e.g., due to weather conditions) cause project delays	• Allow sufficient time during the data collection window for potential delays due to unfavourable weather conditions
The optimal data collection window is missed and the project as a result takes longer than expected	• Plan clear objectives and requirements for each stage of the project to ensure any requirements (e.g., permits, consultant availability) are met early in the project
Ability to collect vehicle age and class data for different vehicle types is not considered and the information is not obtained	• Ensure the emissions testing study is adequately scoped and designed in terms of target vehicles and the necessary equipment set up to collect both the emissions information and the vehicle registration information (e.g., difference in licence plate location on heavy-duty versus light-duty vehicles is considered)
Difficulties in collecting registration data from out-of-jurisdiction vehicles impact study results and the project schedule	• Determine the process for obtaining out-of-jurisdiction registration information early in the project (e.g., once project charter is approved by the CASA Board)
Vehicles avoid the study testing locations	• Take potential testing site avoidance into consideration when determining the testing site locations
Stakeholder Engagement	
During stakeholder engagement, "interested parties" don't agree with the list of management actions provided in Objective 4	• Try to develop the potential management actions collaboratively • If stakeholders disagree, seek to understand stakeholder reasons for disagreement • Identify non-consensus recommendations where appropriate
Lack of engagement/ownership on project team (incl. human resources)	• Identify and communicate with potential stakeholders early in the process • Create a clear value proposition • Be clear about what is being asked of stakeholders
Obtaining stakeholder feedback and refining management actions with interested parties (Objective 4) takes longer than expected, or causes scope creep	• Set specific parameters for this piece of work: • Purpose of soliciting feedback • Scope of influence outcomes will have on overall process • Time available

Operating Terms of Reference

An Operating Terms of Reference describes how the project team agrees to work together. The project team should discuss and reach consensus on the following items:

- Requirements for quorum
- Governance
- Meeting protocols
- Roles and expectations of project team members
- How decisions will be made
- Ground rules
- Frequency of project team meetings
- Frequency of updates and reports to the CASA Board
- Protocols for handling media requests
- Protocols for providing updates to interested parties
- Any other considerations for working together

Stakeholder Analysis and Engagement Plan

The transportation sector is broad and would benefit from engaging different stakeholders for different purposes. Different stakeholders could be engaged in a variety of capacities and at different times throughout the project.

The working group identified the following categories of stakeholders that may be involved:

- Project team: Stakeholders who are required at the table to reach consensus agreement.
- Corresponding members: Stakeholders who receive all correspondence but are not required at the table to reach consensus agreement.
- Task groups or technical experts: Stakeholders who have a specific interest or expertise and can be engaged in a more focused way.
- Other:
    - Stakeholders from whom feedback on management actions is sought, which may include potential implementers or those potentially impacted (Objective 4)
    - Members of the public who may be engaged (Objective 5)

Table 4 includes a list of potential stakeholders for consideration.

TABLE 4: POTENTIAL STAKEHOLDERS TO CONSIDER FOR INVOLVEMENT IN THE ROVER III PROJECT	
Individual or Organization	**Possible Interests, Concerns, or Involvement**
Provincial Regulators[38] (e.g., Environment and Parks, Transportation, Agriculture and Forestry, Alberta Energy Regulator, Service Alberta, Alberta Justice, Alberta Health)	• Responsible for ensuring achievement of the CAAQS as well as provincial policy • Will likely be responsible for implementing many management actions • Interested in environmental protection and health of Albertans as well as ensuring sustainable economic prosperity • Involved in education/awareness initiatives • May be involved in implementing management actions or have interest in certain sectors (e.g., forestry trucks, shuttle buses to mine sites) • May be involved for emissions testing study site access and vehicle registry data access
Federal government (e.g., Environment and Climate Change Canada, Transport Canada)	• Interested in ensuring achievement of the CAAQS across Canada, effectiveness of and alignment with federal policies, as well as meeting transboundary commitments
Municipalities	• Involved in education/awareness initiatives • Involved in site selection and permit acquisition • May be involved in implementing management actions
First Nations and Métis	• Interested in ensuring the health of communities • Interested in protecting the environment
Trucking companies/associations (e.g., CTA/AMTA, Independent Trucking Association)	• Interested in fairness across the sector • Concerns regarding possible costs or inconvenience of potential management actions
Industry	• Interested in management actions to reduce NO_x emissions that include both industrial and non-industrial emission sources
Pacific NorthWest Economic Region (PNWER) Foundation	• Interested in awareness of requirements in each jurisdiction for cross-border activities
Health and Environmental Non-government Organizations	• Interested in ensuring the health of Albertans • Interested in protecting the environment
Airshed Organizations	• Involved in education/awareness initiatives • May be involved in implementing management actions
Agriculture Associations (e.g., Alberta Canola Producers, Alberta Beef Producers, etc.)	• Interested in fairness across the sector • Concerns regarding possible costs or inconvenience of potential management actions
Academia/Research Councils (e.g., U of A Centre of Smart Transportation, and others)	• Interested in data collected and potential research implications of study results, or in possible concurrent studies

Given the different stages of this project, other stakeholders may become apparent as the work progresses. The project team will need to regularly evaluate whether the appropriate stakeholders are engaged.

38 Provincial government ministries change names through time, and these were the names at the time of writing. As of 2024, Environment and Parks is now Environment and Protected Areas, Transportation is now Transportation and Economic Corridors, and Agriculture and Forestry is now Agriculture and Irrigation.

Appendix A: Working Group Membership

	Role	Organization
Members		
Randy Angle	Member	Prairie Acid Rain Coalition
Andrew Barnes	Member	Alberta Motor Transport Association
Ann Baran	Member	Southern Alberta Group for the Environment
Rhonda Lee Curran	Chair	Alberta Environment and Parks
Rob Hoffman	Member	Canadian Fuels Association
Rahul Shrivastava	Member	Alberta Transportation
CASA Secretariat		
Katie Duffett	Project Manager	Clean Air Strategic Alliance
Cara McInnis	Administrative Support	Clean Air Strategic Alliance

Appendix B: Reference Materials[39]

The project team should review the following materials in preparation for project initiation:

- Recommendations for Non-Point Air Emissions Sources in Alberta (CASA, 2017)
  - Final report from the CASA Non-Point Source project teams. Contains recommendations for the transportation sector in Alberta, including the recommendation for the ROVER III project.
  - *Available at:* http://www.casahome.org/current-initiatives/non-point-source-project-team-37/
- Greater Vancouver Regional District Remote Sensing Device (RSD) Trial for Monitoring Heavy-Duty Vehicle Emissions (Envirotest Canada, 2013)
  - A short-term study completed in British Columbia that collected emissions information for a variety of diesel vehicles and model years using a remote sensing device system and a heavy-duty emissions tunnel.
  - *Available at:* http://www.metrovancouver.org/services/air-quality/AirQualityPublications/2013_RSD_HDV_Study.pdf
- The Alberta ROVER Project Summary Report (CASA, 1999)
  - Summary report for the first ROVER project completed through CASA in 1998–1999. Includes the results from the emissions testing study and recommendations developed by the Vehicle Emissions Implementation Design Team.
  - *Available at:* http://www.casahome.org/uploads/source/Alberta%20ROVER%20Project%20(March%201999).pdf
- The Alberta ROVER II On-Road Vehicle Emissions Survey (CASA, 2007)
  - Summary report for the second ROVER project completed through CASA in 2006–2007. Includes the results from the emissions testing study and recommendations developed by the Vehicle Emissions Team.
  - *Available at:* http://www.casahome.org/uploads/source/PDF/ROVERII_Report_FINAL-8JAN2008.pdf

39 Links to resources were correct at the time of writing, but some resources may have moved or been removed.

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Appendix D – Report from Opus Inspection Inc.

The Roadside Optical Vehicle Emissions Reporter III: A Survey of On-Road Light and Heavy-Duty Vehicle Emissions report can be viewed by scanning the following QR code or clicking the link below.

https://www.casahome.org/uploads/source/ROVER_III_Opus_Report-Final_Nov_2023_(amended)_v.2.pdf

Appendix E – Communications Plan

BACKGROUND

The CASA NPS project (2015–2017) was tasked with helping address non-point source air emissions contributing to ambient $PM_{2.5}$ and O_3 standard non-achievement in Alberta. It had a large focus on the transportation sector, and the ROVER III project was informed by recommendations from this project.

Based on the 2014 Air Pollutant Emissions Inventory, the on-road transportation sector is a large emission source of NO_x (particularly HDDVs, followed by light-duty gasoline trucks and other vehicles), a source of VOCs (particularly light-duty gasoline trucks and other vehicles), and a source of primary $PM_{2.5}$ (particularly HDDVs). In 2012, the International Agency for Research on Cancer classified diesel engine exhaust as carcinogenic to humans based on evidence that exposure is associated with an increased risk for lung cancer. More recently, Health Canada published a document that categorizes the relationship between lung cancer and diesel exhaust as causal based on a weight-of-evidence analysis of epidemiological data; the document also identifies a suggestive relationship between bladder cancer and diesel exhaust.

Work on the ROVER III project began in April 2018, with the goal of measuring emissions from the in-use on-road transportation sector, particularly diesel-fuelled trucks, to inform management actions and next steps for transportation emission management to help achieve air quality standards and objectives in Alberta. The project was completed in September 2024.

GOALS

Implementation of this plan is intended to support communication of the following:

- The work of the project team during the project and after its completion.
- Information on the emissions from the in-use on-road transportation sector, particularly diesel-fuelled trucks, in Alberta.
- The health impacts of emissions from the in-use on-road transportation sector, particularly diesel-fuelled trucks, in Alberta.
- Changes in emissions from the transportation sector over time (i.e., comparisons to ROVER I and ROVER II).

AUDIENCES

The audiences for these documents are outlined in the table below.

Sector/Group	Example Organizations
CASA	Member and partner organizations and their networks
Policy-makers	Provincial ministries and agencies (e.g., Alberta Environment and Protected Areas, Alberta Transportation and Economic Corridors, Service Alberta, Alberta Health)
	Federal government (e.g., Environment and Climate Change Canada, Health Canada, Transport Canada)
	Municipalities (large urban, small urban, rural)
Other health organizations	Alberta Health Services
Research and educational institutions	University of Alberta, Simon Fraser University, International Council on Clean Transportation Other post-secondary institutions and school boards
Industry	Transportation associations (Alberta Motor Transport Association, Alberta Motor Association, Alberta Motor Vehicle Industry Council, commercial operators, fleet operators)
	Agricultural associations (Alberta Canola Producers, Alberta Beef Producers)
Health and environmental non-government organizations	Alberta Lung Association
	Alberta Environmental Network
Other non-government organizations	Pacific NorthWest Economic Region (PNWER) Foundation
Indigenous communities and Métis	Samson Cree Nation
	Métis Settlements General Council
General public	Albertans

PROPOSED APPROACH

The project team will use the following communication tools and methods:

1. A factsheet on the ROVER III data collection, containing:
    a. An overview of the ROVER III project.
    b. Locations where data is being collected.
    c. Information on the types of data being collected.
    iv. Information on how the data will be used.
2. A factsheet on the ROVER III project, containing:
    a. An overview of CASA and the consensus process.
    b. The ROVER III project scope and goal.
    c. Key findings and recommendations from the project team.
3. A message map to support CASA members' and partners' communication on the project, containing:
    a. Main message(s) on outcomes of the project.
    b. Key messages supporting the main message(s).
    c. Evidence or examples to support the key messages.
4. Posts on CASA's website and social media accounts, including:
    a. Posting all project documentation (e.g., the final report, consultant report, and factsheets) on the ROVER III project web page.
    b. Posting factsheets and other relevant articles and information brought forward by CASA members on CASA's Facebook and X pages, as well as YouTube, when appropriate.
    c. Include information on the ROVER III project in other CASA communications, such as newsletters or factsheets for distribution to the Alberta Water Council, Indigenous communities, and the public.
5. Leveraging CASA's partner networks, by:
    a. Using partner networks and social media to share the ROVER III project documentation where appropriate.
    b. Sharing the ROVER III project documentation with groups engaged through previous CASA transportation-related projects (e.g., the partners identified during the IRTAQ project).
6. A webinar from CASA and its partners on the ROVER III project and other transportation-related projects in Alberta and elsewhere, involving:
    a. ICCT
    b. Opus
    c. AMTA
    d. University of Alberta
    e. Simon Fraser University
    f. Alberta Airsheds Council and individual Airshed Organizations
    g. Environment and Climate Change Canada
    h. Other CASA project team members and partners (e.g., IRTAQ project, the CAAQS project)
7. A YouTube video on the project and its outcomes, along with information on related CASA projects.
8. Template presentations, memos, and other documents CASA members can use to communicate about the project to their networks.

Details on the content of a webinar or webinar series can be found in recommendation 7 of this report. CASA may wish to complete this webinar or webinar series as part of an overarching project or strategy on air literacy and education.

BUDGET

The communications plan and any related project documentation will be made available electronically. Physical copies of the project's final report will be available, with printing costs expected to be less than $5,000.

KEY MESSAGES

Key messages about this project and its outcomes are detailed below.

ROVER I, II, and III Projects

- The ROVER III project is CASA's third project on measuring emissions from Alberta's in-use on-road vehicle fleet. ROVER I and ROVER II were completed in 1998 and 2008, respectively, and both focused on LDGVs.
- The ROVER III project is focused on using remote sensing technology to measure emissions from HDDVs, but data was also collected for LDGVs.
- ROVER III data collection sites were in Calgary, Edmonton, Fort McMurray, Grande Prairie, Red Deer, and VISs throughout Alberta.
- CASA partnered with Service Alberta to obtain vehicle characteristic data based on licence plates. All personally identifiable information was removed from the data before it was analyzed; the collected emissions data cannot be linked back to individual vehicles or the drivers of the vehicles.

Funding

- The ROVER III project was made possible through generous financial contributions from the International Council on Clean Transportation, Alberta Transportation and Economic Corridors, the Canadian Fuels Association, and Alberta Environment and Protected Areas.

Alberta's Air Quality

- Air emissions need to be managed for Alberta to achieve air quality standards and objectives, which will become more stringent over time. In particular, careful management of emissions of NO_x will be needed.
- The transportation sector is one of the largest sources of NO_x emissions in the province, contributing approximately 30% of total NO_x emissions. It is also a source of primary $PM_{2.5}$, VOCs, and GHGs.

Impacts of Air Quality on Human Health

- Even low levels of pollutant exposure can lead to negative short- and long-term health effects.
- Traffic-related air emissions have impacts on health for people in all areas of Alberta.
- Reducing traffic pollutants is anticipated to reduce health impacts such as hospital admissions, emergency room visits, doctor visits, and lost work or school time.
- Alberta has the largest diesel exhaust emissions in Canada. There are negative health impacts from diesel emissions.

Emissions from Alberta's in-use on-road Transportation Fleet

- Vehicles that have had emissions control systems removed or defeated, or vehicles that have malfunctioning emissions control systems, can emit pollutants at rates many times higher than vehicles with properly functioning emissions control systems.
- The link between transportation emissions and health is well established, but the ROVER III study did not examine the degree of impact that excess emissions from malfunctioning emission controls have on health.
- Based on the data collected through the ROVER III project, up to 30% of Alberta's HDDVs may have tampered with or malfunctioning emissions control equipment.
- Reducing the frequency of tampered with or malfunctioning emissions control equipment, particularly for HDDVs, will reduce adverse air quality impacts on Albertans.

Conduct Proper Vehicle Maintenance

- Follow regular vehicle maintenance schedules to reduce emissions while benefiting the safety and life of your vehicle.
- Maintain proper pressure in your tires to improve fuel efficiency (reduce emissions), reduce tire wear (save money), and improve safety by increasing traction.
- Keep your vehicle's emission control system in good working order.
- Idling not only impacts emissions and fuel consumption, but also vehicle wear.

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