



RED DEER FINE PARTICULATE MATTER RESPONSE

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Alberta
Government

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MANDATE

The Red Deer Fine Particulate Matter Response was initiated in 2013 in response to an exceedance of the Canada-wide Standard (CWS) for fine particulate matter at the Red Deer Riverside ambient air monitoring station under the former Clean Air Strategic Alliance *Particulate Matter and Ozone Management Framework*. The *CASA Particulate Matter and Ozone Management Framework*, based on the 24-hour CWS has been Alberta's platform for CWS implementation for the past decade. The *Red Deer Fine Particulate Matter Response*, developed according to the requirements set out in the former framework, is an action plan of the Government of Alberta and stakeholder commitments to address the fine particulate matter issue in the Red Deer area. The *Red Deer Fine Particulate Matter Response* focuses science investigation and management actions on an area defined as the Red Deer Air Quality Management Area. The Red Deer air quality management area is a place-based management area within the Red Deer Air Zone.

Although the mandate to develop the mandatory response action plan was triggered by the CWS, implementation and progress of the Response will be assessed, evaluated, and reported on against the numerical Canadian Ambient Air Quality Standards (CAAQS), which were introduced in 2015. For more information on Alberta's transition to managing for CAAQS in the Red Deer Air Zone, refer to the Red Deer Air Zone Fine Particulate Matter Response: Government of Alberta Action Plan (herein referred to as the GoA Action Plan) published with this Response. Implementation of this Red Deer Fine Particulate Matter Response will continue to inform and align with the provincial approach to managing toward the CAAQS in the Red Deer Air Zone while continuing to focus on the priority fine particulate matter issue in the Red Deer air quality management area, as defined in this action plan.

EXECUTIVE SUMMARY

The Red Deer Fine Particulate Matter Response (the Response) was initiated in 2013 when Alberta Environment and Parks published the annual ambient air quality assessment for the 2009-2011 data period found that Red Deer Riverside ambient air quality monitoring station exceeded the CWS for fine particulate matter. The results triggered the development of a mandatory response action plan (the Response) to address the exceedance as required in the former *CASA Particulate Matter and Ozone Management Framework*. For more on Alberta's transition to managing toward the CAAQS for fine particulate matter, refer to the accompanying GoA Action Plan.

A preliminary science investigation indicated that secondary fine particulate matter and meteorological conditions were factors in the CWS exceedances. This investigation drew on findings from the Capital Region Fine Particulate Matter Response. The investigation highlights that managing major sources of nitrogen dioxide and volatile organic compounds may be effective means of reducing secondary fine particulate matter. Major sources include transportation, upstream oil and gas facilities and to a lesser extent chemical manufacturing, as well as residential and commercial heating. Details from the science investigation are summarized in the Red Deer Fine Particulate Matter Science Report, released as an accompanying document to this Response.

From the science investigation findings, Alberta Environment and Parks was able to define the boundary for the Red Deer Fine Particulate Matter Response based on ambient air quality information available in 2014 relevant to observations at the Red Deer Riverside ambient air monitoring station. The defined air quality management area includes stakeholders anticipated to be contributing to the fine particulate matter issue and was established with the intent to better understand the local air quality conditions and to identify areas where emission reductions are necessary to improve the local air quality.

The Response demonstrates the regionally collaborative approach to better understand the fine particulate matter issue within the identified Red Deer air quality management area and recognizes the influence that other stakeholders have in supporting the management of this issue. The Response and accompanying GoA Action Plan communicate the Government of Alberta's commitments and transition to managing toward the CAAQS within the Red Deer Air Zone.

Air quality management is complex and warrants leadership from Alberta Environment and Parks with strong stakeholder engagement. As a result, the collaborative approach to develop the Response is threefold:

1. A multi-stakeholder Advisory Committee was convened in 2014 to provide strategic advice to Alberta Environment and Parks in development of the Response.
2. Alberta Environment and Parks worked closely with Parkland Airshed Management Zone (PAMZ) Technical Working Group to receive and gather feedback on the science investigation into the fine particulate matter issue within the air quality management area.

3. Alberta Environment and Parks worked closely with the PAMZ Communications Committee to develop an education and engagement strategy to inform the public and broader stakeholders about the fine particulate matter issue in the air quality management area, the Response, and next steps.

At the beginning of 2015, the CAAQS replaced the CWS for fine particulate matter and ground-level ozone. The boundary to achieve the CAAQS differs from the CWS approach. For more information on these differences, refer to the accompanying GoA Action Plan. Although the mandate to develop the Response was triggered by the CWS, in order to be consistent, responsive, and future-focused to the increasingly stringent national standards for fine particulate matter, the goal of the Response is to reduce ambient fine particulate matter concentration and remain below the numerical CAAQS as measured at ambient air quality monitoring stations within the Red Deer air quality management area. The three main objectives to achieve this goal in the Red Deer air quality management area are:

Action: The development and implementation of management actions that can be implemented throughout the year to achieve measurable reductions of fine particulate matter concentrations;

Investigation: Scientific investigation to improve knowledge of fine particulate matter in the Red Deer air quality management area; and

Engagement: Engagement to promote public and stakeholder actions to work towards a solution to the fine particulate matter issue.

Alberta Environment and Parks and the Advisory Committee members compiled an inventory of committed and proposed actions to address the management gaps identified during the development of the Response. These actions are based on the above three objectives and are intended to address emission sources contributing to the fine particulate matter issue within the defined Red Deer air quality management area. For more information on the Government of Alberta commitments to meeting the CAAQS in the Red Deer Air Zone, refer to the accompanying GoA Action Plan.

ACKNOWLEDGEMENTS

This document was developed using a collaborative, multi-stakeholder approach with representation from the Government of Alberta, industries, municipalities, public members, and the Parkland Airshed Management Zone. Members and participants engaged their organizations and dedicated their time in the completion of the Response and associated documents.

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 Adam Jensen (alternate) – Alberta Health Services
 Allison Fisher – Shell Canada
 Andrea Brack – NOVA Chemicals
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PRIORITY ISSUE

Fine particulate matter can be emitted directly into the atmosphere as primary fine particulate matter or it can be formed in the atmosphere from precursor gases reacting under certain meteorological conditions as secondary fine particulate matter.

Alberta Environment and Parks performs annual ambient air quality assessments for fine particulate matter concentration, in addition to other pollutants using data collected at ambient air quality monitoring stations throughout Alberta. The PAMZ monitoring network, operating in the Red Deer area, includes both passive and continuous monitoring stations. Within the network there are three continuous ambient air monitoring stations – Riverside, Caroline, and Lancaster, as shown in Figure 1 – which continuously measure fine particulate matter concentration and report it to the CASA Data Warehouse. Caroline monitoring station is located approximately 60 kilometres southwest of Red Deer and 16 kilometres south-southeast of the Town of Caroline. The Riverside station is located within the City of Red Deer, adjacent to the Three Mile Bend recreation area and near Riverside industrial area. The Lancaster monitoring station, located in the Lancaster Green neighbourhood of south Red Deer, was temporarily deployed for the winters of 2012 – 2013 and 2013-2014 before becoming a permanent continuous monitoring station in December 2014. Table 1 captures the classification and initial date of operation for the three monitoring stations.

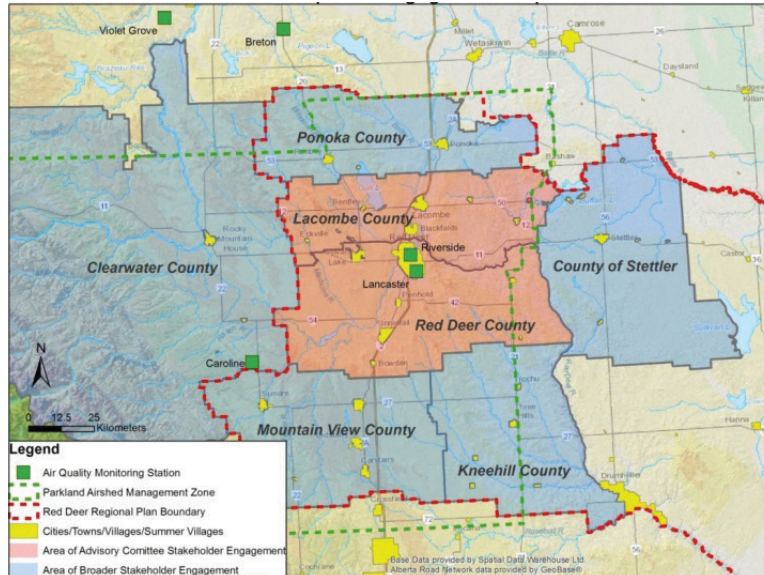


Figure 1: Map of the Active Continuous Ambient Air Quality Monitoring Stations in the Red Deer Air Quality Management Area.

Table 1: Active Continuous Ambient Air Quality Monitoring Stations within the Red Deer Air Quality Management Area*

Monitoring Station	Commencement of Operation	Classification
Riverside	May 1, 2005	Commercial
Caroline	January 12, 1999	Rural
Lancaster	Winter 2012-2013 Winter 2013-2014 December 2014 - present	Residential

*See Response section “Air Quality Management Area” for a definition of this area and how it related to the Red Deer Air Zone for CAAQS management and the Red Deer Land-use Framework regional plan boundary

Each monitoring station is assigned a management action level based on the annual ambient air quality assessments for fine particulate matter concentration. The actions associated with lower action levels provides time to address ambient concentrations. Each higher management action level prescribes successively more stringent management actions, including their priority and urgency.

At the time of the 2009-2011 ambient air quality assessment, Riverside and Caroline monitoring stations met the data completeness requirements and were used in determining the assignment of the management action levels to the monitoring stations.

The annual assessment for the 2009-2011 data period identified that Riverside monitoring station exceeded the CWS for fine particulate matter, placing the station in the ‘Mandatory Plan to Reduce Below the CWS’ action level, as described in the CASA Particulate Matter and Ozone Management Framework. The former CASA Particulate Matter and Ozone Framework is Alberta’s approach to achieving the CWS.

Figure 2 shows the fine particulate matter concentrations for the current and previous annual assessments at Riverside monitoring station. The station exceeded the national standards for fine particulate matter for the 2010-2012 annual assessment (released in April 2014).

Managing particulate matter is important because health-related studies have linked particulate matter – especially fine particulate matter- to cardiac and respiratory diseases such as asthma, bronchitis, emphysema, and various

forms of heart diseases. Smaller particles (fine particulate matter) can penetrate deeper into the lungs, irritating the respiratory system, reducing the effective surface area of oxygen exchange, or transferring toxic and carcinogenic compounds in fine particulate matter into the blood stream. Particulate matter can also affect plant health, the balance of nutrients in soil and water, and can contribute to soil and water toxicity.

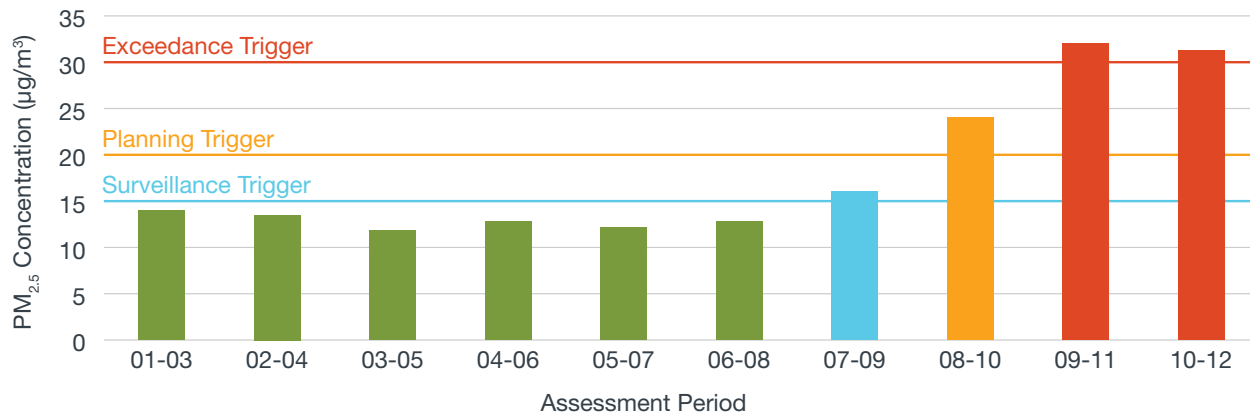


Figure 2: The CASA Particulate Matter and Ozone Management Framework Annual Assessment for 2001-2002 reported against the CWS for fine particulate matter.

AIR QUALITY MANAGEMENT IN ALBERTA

Air quality management in Alberta has evolved over time to adapt to changing needs and improved knowledge. Air quality has traditionally been managed for industrial facilities, specific populations, and ecologically sensitive areas, and has recently evolved to a cumulative effects management approach.

In October 2012, the Canadian Council of Ministers of the Environment (CCME), with the exception of Quebec, agreed to begin implementing a new Air Quality Management System (AQMS). The AQMS is a national approach to air quality management in Canada, developed in partnership between Environment Canada, individual provinces, territories, non-government organizations, and industry. The goal of the AQMS is to achieve better air quality and significant health and environmental benefits for Canadians by keeping clean areas clean and through continuous improvement. The AQMS considers the contributions from regulated and non-regulated sources, point and non-point sources, and offer regulatory and non-regulatory actions that can be applied to achieve the CAAQS. The use of thresholds, management levels, and limits in the AQMS ensures that a comprehensive and proactive approach is taken to protect air quality in accordance with the principles of keeping clean areas clean and continuous improvement. This approach has been adopted into the Land-use Framework regional air quality management frameworks in Alberta, which allows for proactive management of air quality that can address the unique pressures, conditions, and requirements of air zones within the province. The Red Deer Air Quality Management Framework will be developed as part of the Red Deer Regional Plan. More information on how air quality is managed in Alberta can be found in Appendix A.

FINE PARTICULATE MATTER MANAGEMENT

Just as air quality management has evolved over time, so too has management specific to fine particulate matter. When the National Ambient Air Quality Objectives (NAAQS) for Total Suspended Particles (TSP) were established under the *Clean Air Act* in 1970s, the health and environmental effects related to the finer fractions of particulate matter were not well understood. Even in the 1980s, the role of particulate matter as a major component of smog was not recognized. Through the 1990s, evidence of the serious health implications of inhaling particulate matter grew with scientific studies. This has led to the establishment of the CWS for particulate matter in 2000.

In 2001, the federal government declared particulate matter less than 10 microns in diameter (PM₁₀) to be toxic and included it in the *Canadian Environmental Protection Act* (1999), with an emphasis on the finer fraction (PM_{2.5}) of fine particulate matter. In 2003, the primary precursors to secondary particulate matter – nitrogen oxides (NO_x), volatile

organic compounds (VOCs), sulphur dioxide (SO₂), and ammonia (NH₃) were also declared to be toxic on the basis of their contribution to particulate matter formation.

Key initiatives that drive fine particulate matter management in the Red Deer air quality management area are highlighted in the bullets below. It should be acknowledged that not all of these initiatives are focused directly on reducing precursor emissions to secondary fine particulate matter. Nevertheless, they each play distinct and important roles in the overall management of fine particulate matter.

KEY INITIATIVES FOR FINE PARTICULATE MATTER IN THE RED DEER AIR QUALITY MANAGEMENT AREA

National

- Air Quality Management System
 - The AQMS includes work to address emissions from mobile sources. Priorities are to reduce emissions through advanced transportation technologies and proper vehicle maintenance, initiatives targeting in-use diesel vehicles and engines, and by greening fleets.
 - The CWS for fine particulate matter have been in effect since 2000. These standards establish an inter-governmental commitment to reduce fine particulate matter and its associated risks to human health and the environment. These standards were replaced by increasingly more stringent CAAQS. Jurisdictions are expected to report their annual assessments and manage air quality against CAAQS starting in 2015.
 - Policies such as the base-level industrial emissions requirements (BLIERs) ensure that all industrial sources across the country are meeting at least the national standards. The first three of these BLIERs apply to the cement sector, gas-fired non-utility boilers and heaters, and stationary gas-fuel fired engines.

Provincial

- The Alberta Ambient Air Quality Objectives provide the provincial 24-hour and annual objectives for fine particulate matter.
- Under BLIERs, industrial release source limits help to ensure pollution prevention and control technologies are adopted to adequately protect the environment.
- Key provincial management frameworks, such as the Acid Deposition Management Framework and the Emissions Management Framework for the Alberta Electricity Sector, guide the management reduction of fine particulate matter and precursor pollutants, such as nitrogen oxides and sulphur dioxide.

Regional

- The PAMZ Ozone Management Plan was developed in 2008 as a result of the region's air quality monitoring stations exceeding the CASA Particulate Matter and Ozone Management Framework 'Management Plan' action trigger of 58 parts per billion for ozone. Ozone is formed through photochemical reactions between nitrogen oxides and volatile organic compounds. Therefore, management of ozone and its precursors will also assist in the management and reduction of fine particulate matter concentration in the Red Deer air quality management area.

INVESTIGATING THE CAUSE OF THE EXCEEDANCES

The Red Deer Fine Particulate Matter Science Report (the Science Report) was developed in an effort to characterize the cause of the fine particulate matter exceedance at Red Deer Riverside monitoring station in order to inform the Response and accompanying management action. The Science Report was developed internally by Alberta Environment and Parks with external consultation from the PAMZ Technical Working Group. The intent of the Science Report was to investigate the cause of the exceedance, to the highest degree that available data can support to inform direction and stringency of management actions by sector.

The Science Report focuses on Red Deer Riverside monitoring station. The only other permanent continuous air quality monitoring station in the vicinity of the City of Red Deer in 2013 was the Caroline monitoring station (60 kilometre distance). For the 2009-2011 assessment, Caroline monitoring station was reported to be in the 'Baseline Monitoring and Data Gathering' action level which is the lowest of the four action levels under the CASA Particulate

Matter and Ozone Framework. For this reason, investigating the observed fine particulate matter concentrations at Caroline monitoring station was not a focus of the Science Report.

Three main discussion topics were derived from a series of investigative questions developed by Alberta Environment and Parks. The development of the investigative questions was informed by the need to inform management actions to reduce ambient fine particulate matter levels and as the need to address specific questions raised by stakeholders. These discussions focused primarily on the observations from Red Deer Riverside monitoring stations but also drew upon additional data where appropriate. While some of the key findings are summarized below; details on the full investigation, findings, and recommendations can be found in the Red Deer Fine Particulate Matter Science Report.

MEASUREMENT OF PARTICULATE MATTER

Red Deer Riverside monitoring station has been measuring fine particulate matter concentrations since 2001. Monitoring technology for fine particulate matter has improved and as such, instrumentation changes have been made twice at Red Deer Riverside station—once in 2009 and again in 2013. The 2009-2011 CWS ambient air quality assessment for fine particulate matter coincided with the adoption of a new monitoring method and instrument at Red Deer Riverside. The step-change in fine particulate matter concentrations observed in March 2009 occurred at the same time as the monitoring change. It is important to acknowledge the differences between the monitoring technologies at Red Deer Riverside in order to better understand its influence on the observed fine particulate matter concentration.

INFLUENCE OF METEOROLOGY

Event days are defined as 24-hour averaged fine particulate matter concentrations (midnight-midnight) greater than $19\mu\text{g}/\text{m}^3$. At Red Deer Riverside monitoring station, it is evident that non-forest fire related fine particulate matter event days can occur in all seasons, however, the majority of the event days occur between October and March as shown in Figure 3. There is some variability between years, as to the frequency of non-forest fire related event days, however in all years, the number of events occurring between October and March is greater than the balance of the year. Event days with elevated fine particulate matter concentration as a result of forest fire are removed from the provincial ambient air quality annual assessment.

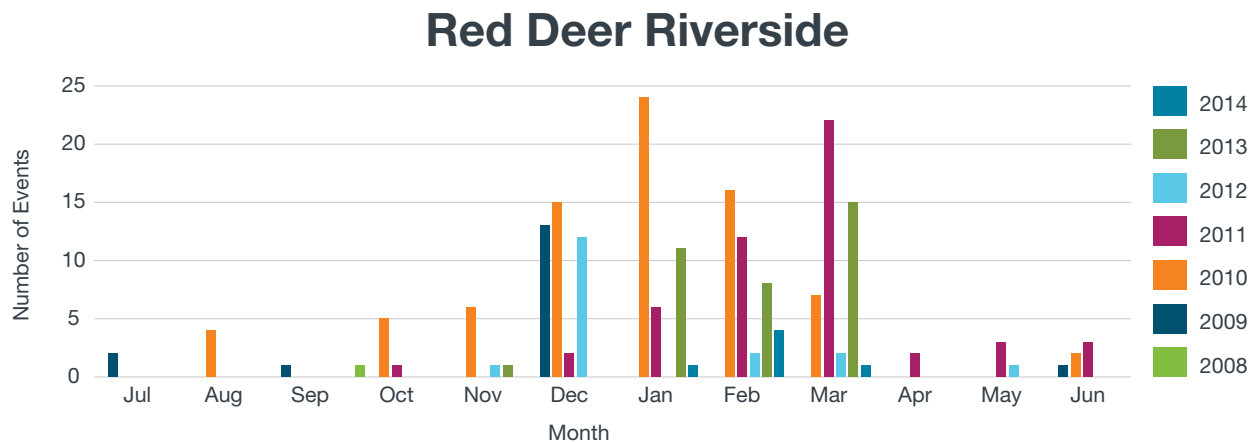


Figure 3: Seasonal distribution of fine particulate matter event days

Fine particulate matter event days are distinctly associated with low to moderate wind speeds and temperature inversions. Lower wind speeds inhibit dispersion of fine particulate matter and other pollutant gases. Temperature inversions occur when cold air is trapped near the surface by a layer of warmer air aloft. This condition prevents air that has been warmed due to daytime heating from rising and mixing and consequently, dispersing pollutants.

The seasonal variation of event days and the association of event days with lower wind speeds suggest that dispersion limiting mechanisms are driving fine particulate matter events at Red Deer Riverside monitoring station.

The vast majority of events were associated with southerly wind direction; however, upwind of Red Deer Riverside monitoring station, there is no single large source of fine particulate matter. Therefore, in the case of Red Deer Riverside monitoring station, the association of fine particulate matter with southerly wind directions is likely related to other phenomenon. One such phenomenon may be topographical channeling.

MULTI-STATION EVENTS

Fine particulate matter event days frequently occur concurrently at air quality monitoring stations in the Edmonton, Red Deer, and Calgary areas during the wintertime (October to March). Twenty-four hour averaged fine particulate matter concentrations measured on event days in February 2011, from 19 air quality monitoring stations within the vicinity of Edmonton, Calgary, and Red Deer were compared. The findings showed that fine particulate matter concentrations were highest simultaneously in areas of higher population density with lower concentrations measured outside of these areas.

The presence of frequent multi-station events suggest that sources within Edmonton, Calgary, and Red Deer are contributing to fine particulate matter events, and that these multi-station events are driven by large scale meteorology which influences large areas of the province at the same time.

IMPLICATIONS OF THE SCIENCE REPORT FINDINGS

The findings of the science investigation provide valuable information to better understand the factors contributing to the fine particulate matter issue. The science investigation determines that effective management should focus on reducing nitrogen dioxide emissions. Key sources of nitrogen dioxide in the Red Deer air quality management area are upstream oil and gas facilities and transportation related emissions, such as on-road mobile sources and off-road diesel vehicle sources. The Science Report includes recommendations for next steps to continue to inform appropriate management decisions in the Red Deer air quality management area.

RED DEER AIR QUALITY MANAGEMENT AREA

Findings from the science investigation for the exceedance of the 24-hour CWS for fine particulate matter suggest that wintertime fine particulate matter concentrations in Red Deer behave similarly to that observed in Alberta's Capital Region. Without speciation data in the Red Deer area, results from the Capital Region monitoring survey were used to infer that wintertime fine particulate matter concentrations might be driven by the formation of ammonium nitrate, for which nitrogen dioxide is a precursor compound. Based on this assumption the spatial distribution of nitrogen dioxide as shown in Figure 4 was used to define the boundary for the Red Deer Air Quality Management Area. This area consists of the 'Area of Broader Stakeholder Engagement', which includes Ponoka County, Mountain View County, Kneehill County, and Clearwater County. Although these counties contain some area of higher nitrogen dioxide concentrations, they do not have the same population or industrial density as Red Deer County and Lacombe County.

The air quality management area also includes the geographic area titled, 'Area of Advisory Committee Stakeholder Engagement', which includes Red Deer County, Lacombe County, and the towns, villages, summer villages, and cities contained within their boundary. The vast majority of the nitrogen dioxide sources expected to be contributing to the fine particulate matter issue are located in this geographic area.

Both the engagement boundaries for the 'Area of Broader Stakeholder Engagement' and 'Area of Advisory Committee Stakeholder Engagement' are shown in Figure 5. Additional information on how the engagement boundaries were defined can be found in the corresponding Red Deer Fine Particulate Matter Science Report.

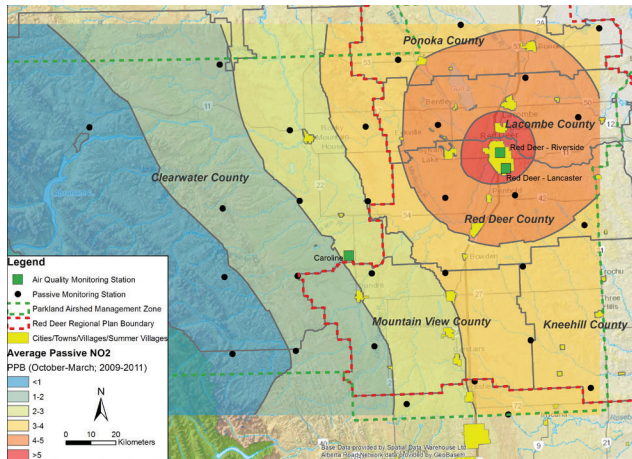


Figure 4: Spatial Distribution of Nitrogen Dioxide.

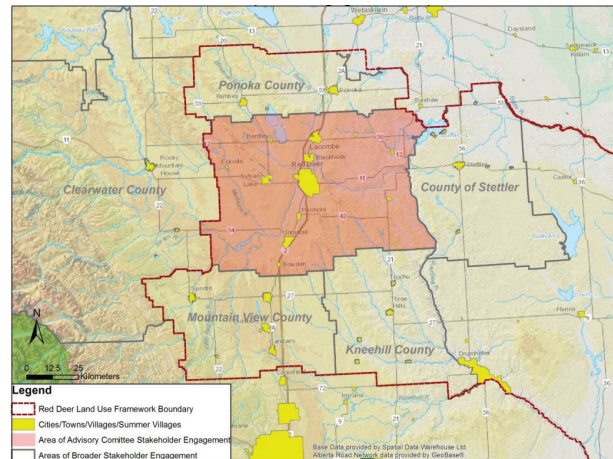


Figure 5: The Red Deer Air Quality Management Area, highlighted in red, was established through analyzing the nitrogen dioxide spatial average.

INDUSTRIES AND BUSINESSES IN THE RED DEER AIR QUALITY MANAGEMENT AREA

The Red Deer air quality management area is located in central Alberta, approximately mid-way between Edmonton and Calgary, bisected by the Queen Elizabeth II Highway (QEII). The QEII is Alberta's busiest highway, which sees more than nine million trips annually by automobiles. Over 74 per cent of the province's population lives along this along the QEII transportation route.

Within the air quality management area, many traditional and emerging businesses and industry sectors are expanding. Traditional sectors include oil and gas; petrochemical; agriculture; food and beverage processing; distribution, wholesale, and retail services; and tourism. Newly emerging sectors include telecommunications and wireless services; biotechnology; value-added agriculture; software development; electronics; and microelectronics.

Industrial and commercial properties within the air quality management area include petrochemical manufacturing (NOVA Chemicals, Dow Chemical Canada ULC, and MEGlobal Canada Inc.), energy industry (Husky Energy, etc.), and other industries (Agrium, Ineos, etc.). Knowledge-based professions, scientific, and technical services supporting the oil and gas industry are largely made up of small firms. The manufacturing industry also continues to grow with metal fabrication as the largest sector of manufacturing in the area followed by machinery, wood cabinetry, and food processing.

The air quality management area also includes a strong agricultural sector. Much of the rural land within the Red Deer development area is actively used for growing crops, feeding livestock, and providing lumber and mineral resources. Intensive farms include dairy, feed lots, hog operations, poultry operations, greenhouses, bison ranches, elk farms, and a variety of exotic animal farms. Access to primary resources is vital to the strong agriculture and agri-processing industry with major meat producers like Olymel and Nossack Food Groups.

Economic growth within the air quality management area is due to its central location in Alberta and proximity to the QEII Highway, which offer businesses an ideal place for transportation, warehousing, and distribution. The Red Deer air quality management area, Calgary Census Metropolitan Red Deer air quality management area, Calgary Census Metropolitan Area, and the Edmonton Census Metropolitan Area are expected to experience the strongest growth within the province. Within the air quality management area, Red Deer, Lacombe, Sylvan Lake, Blackfalds, Penhold, Olds, Innisfail, and Stettler are among the fastest growing communities.

RED DEER AIR QUALITY MANAGEMENT AREA EMISSIONS PROFILE

Emission sources within the Red Deer air quality management area range from large point sources to collectively significant non-point sources. In order to characterize the distribution of emissions from various point and non-point sources, three pollutants of concern were identified: nitrogen dioxide and sulphur dioxide (known precursors to the formation of secondary fine particulate matter), and primary fine particulate matter. Emission sources in the Red Deer air quality management area were determined from the 2008 Alberta Air Emissions Inventory. Details on how the non-point sources were calculated and outlined in the Red Deer Fine Particulate Matter Science Report. Figure 6 shows the sector-based breakdown of nitrogen dioxide, sulphur dioxide, and primary fine particulate matter.

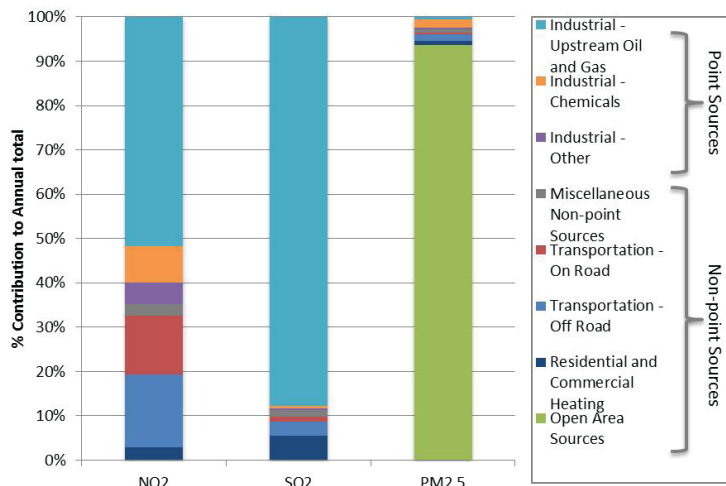


Figure 6: Sector-based breakdown of the fine particulate matter precursors and primary fine particulate matter emissions in Census Division 8.

NITROGEN DIOXIDE (NO₂)

Industrial point sources emit 65 per cent of nitrogen dioxide in the Red Deer air quality management area. The vast majority of point source emissions and more than half of all emissions of nitrogen dioxide are from upstream oil and gas facilities. These facilities are for the most part distributed throughout the Red Deer air quality management area and are largely located outside of population centres. Other industrial point sources include emissions from chemical manufacturing and other industrial activities. Point source emissions do not undergo substantial seasonal fluctuations.

Non-point source emissions are highest in the City of Red Deer as well as Red Deer, Lacombe, and Ponoka counties. Of the sectors contributing to non-point source emissions, transportation related emissions are predominant, accounting for 84 per cent of non-point source emissions of nitrogen dioxide and 30 per cent of nitrogen dioxide from all sources (point and non-point). Other significant non-point source emissions of nitrogen dioxide are from residential and commercial heating and other miscellaneous sources.

Point source is a term used to describe emissions from a single discharge source that can be easily identified. Within the context of this Response, point sources were classified into three key sectors:

- Upstream oil and gas
- Chemical industry
- Other industry which include emissions from petroleum product transportation, electric power generation, and the various industries such as the grain, cement, and asphalt industries.

Emissions from **non-point sources** are spatially distributed emissions from common point, line, or area sources, caused by the release of pollutants from many different and diffuse sources (aggregated sources of emissions). This aggregation is done because the emission sources are either too small and numerous, too geographically dispersed, or too geographically large to be estimated or presented by a single point. Within the context of this Response, non-point sources were classified into several key sectors:

- On-road transportation
- Off-road transportation
- Residential and commercial heating
- Open area sources include emissions from agriculture operations, construction operations, dust from roads (paved and unpaved), prescribed burning, and waste processing
- Miscellaneous sources include incineration sources (e.g. cremation), industrial sources, air transportation, rail transportation, emissions from structural fires, and miscellaneous emissions from cigarette smoking and meat cooking

Of the transportation related emissions, it is approximately evenly split between off-road and on-road sources. On-road emissions are highest from those areas with the greatest populations and therefore the highest road usage. On-road sources do not undergo significant seasonal variation and are expected to be consistent year round. Off-road emissions sources are dominated by diesel fueled vehicles such as construction and agricultural equipment. Smaller contributions come from off-road vehicles and devices with small engines, such as all-terrain vehicles, yard equipment, and aquatic vessels. Contributions to off-road transportation emissions are concentrated near population centres. These activities are largely season dependent and therefore it is expected that off-road emissions are largest in the warmer months.

SULPHUR DIOXIDE (SO₂)

Emissions from sulphur dioxide are approximately 20 times less than nitrogen dioxide emissions in the Red Deer air quality management area and are dominated by upstream oil and gas point sources (accounting for nearly 90 per cent of all sulphur dioxide emissions). Sulphur dioxide emitting point sources are distributed sparsely throughout the Red Deer air quality management area and are mostly located outside of population centres.

Non-point source emissions of sulphur dioxide are predominantly from residential and commercial heating and off-road transportation. The City of Red Deer and Red Deer County have the highest emissions of non-point source sulphur dioxide emissions. Sulphur dioxide releasing non-point sources are concentrated near populated areas.

PRIMARY FINE PARTICULATE MATTER (PM_{2.5})

Point source emissions of primary fine particulate matter are collectively small, with the largest contributions coming from the chemical manufacturing industry.

Nearly the entirety (97 per cent) of primary fine particulate matter is emitted as non-point source emission. Open area sources dominate the non-point source emissions of primary fine particulate matter, which is largely emitted as dust from unpaved roads, and in smaller quantities from construction operations and agriculture. While unpaved roads are found within Red Deer, Lacombe, and Ponoka counties, Red Deer County's location (encompassing the City of Red Deer) means that traffic loads on rural unpaved roads are higher than in other counties, and subsequently result in more emissions of fine particulate matter.

Non-point source emissions from construction operations are expected to be concentrated around population centres and are focused throughout the warmer snow-free months (April – September) as construction operations are limited in the wintertime due to snow-cover and ground freeze-up. These same natural processes also act to limit to emissions of fine particulate matter from unpaved roads.

STAKEHOLDER ENGAGEMENT WORKSHOPS

In January 2015, stakeholders within the 'Area of Broader Stakeholder Engagement' were invited to a workshop on the fine particulate matter issue. The purpose of the information session was to:

- Build awareness and understanding among stakeholders in the Red Deer air quality management area about the fine particulate matter issue;
- Explain how the multi-stakeholder advisory committee and Alberta Environment and Parks were moving forward to prepare the Response; and
- Facilitate discussion about potential actions that could help reduce fine particulate matter in the Red Deer air quality management area.

In June 2015, stakeholders within the 'Area of Broader Stakeholder Engagement' were asked for feedback on the draft Response in a discussion guide format. Feedback from the engagement workshop and discussion guide was incorporated into the Response and implementation plan. A complete list of attendees at the January 2015 session is listed in Appendix B.

JURISDICTIONAL SCAN

A focused jurisdictional scan was completed to explore fine particulate matter management in Golden, British Columbia, and Whitehorse, Yukon. This built upon the existing jurisdictional scan completed as part of the Capital Region Fine Particulate Matter Response. Additionally, the jurisdictional scan evaluated the communications efforts undertaken by the State of Utah during implementation of their fine particulate matter State Implementation Plan.

The focused jurisdictional scan highlighted that both meteorology (temperature inversions and stagnant conditions) and topography can create ideal conditions for higher concentrations of fine particulate matter. These higher concentration events are a symptom of the impact of emission sources on ambient air quality levels, which impact human health. The jurisdictional scan also noted that source apportionment is an important tool in aiding the development of management strategies. Actions pertaining to engagement and communication are critical first steps to ensure that the broader stakeholders and the public are informed of the issue before implementation of policies and regulations. Management actions in other jurisdictions were shown to range from a combination of voluntary and behavioural changes to more stringent regulatory actions. Key learnings from each jurisdiction are summarized below.

GOLDEN, BRITISH COLUMBIA

- The town of Golden and the Columbia-Shuswap Regional District are subject to frequent high levels of particulate matter. Temperature inversions are common in communities located in mountain valleys or in areas that are nestled up against a mountain range where, coupled with stagnant conditions, inversions can prevent upward mixing of the air and result in the build-up of pollutants near the surface. Temperature inversions and stagnant conditions are prevalent during the winter season when daylight hours are reduced.
- The town was chosen as the location for a source apportionment study by the BC Ministry of Environment because of its historical particulate matter (PM₁₀) and fine particulate matter (PM_{2.5}) concentration levels, which have historically been well above the provincial average. Golden was also selected because of its representative topography and sources of a typical interior community in BC. Common sources contributing to high PM levels include wood-stoves, open burning, transportation, rail yards, wood processing, and road dust. The goals of the source apportionment study in Golden were to add to the knowledge base of the air quality in the airshed, and aid the development of management strategies.
- Golden and District Air Quality Committee – a society open to all Golden residents, industry, local, and regional government – is currently drafting an Air Quality Management Plan. Key aspects of the plan include information gathering and sharing, public education, conducting ongoing research, and enhancing public engagement.

WHITEHORSE, YUKON

- A recent study by the World Health Organization ranked Whitehorse as having the best air quality in the world. While the city's sustainability programs aren't designed specifically to address air quality, initiatives like public transit, bike, and pedestrian paths collectively can have an impact. Challenges for the city has been encouraging people not to the idle their vehicles.

STATE OF UTAH

- During the winter, the Wasatch Front (the cities and towns along the western edge of Wasatch Mountain Range) suffers from multi-day wintertime air pollution episodes in which the concentration of fine particulate matter exceeds the National Ambient Air Quality Standards. The bulk of the fine particulate matter observed during these multi-day wintertime episodes are ammonium nitrate (58 per cent), organic carbon (20 per cent), ammonium sulphate (nine per cent) and elemental carbon (five per cent). Precursors of ammonium nitrate particulates are nitrogen oxides and volatile organic compounds.
- Utah's Department of Environmental Quality (the Division of Air Quality) noted that any solutions will require a community response. Consequently, before implementing controls that will limit individual freedom to burn wood or drive cars for example, a great deal of resources have been invested in engagement and communications to ensure that there is consistent messaging and knowledge about the issue.

GUIDING PRINCIPLES

The guiding principles reflect the Response's cumulative effects approach to managing ambient air quality in the Red Deer air quality management area. These principles provide the direction for development and implementation of the Response.

- **Alignment with existing initiatives:** the intent of the Response is to support, rather than replace existing frameworks, policies, and regulations. Aligning the Response's components and management with current initiatives supports and leverages existing work.
- **Regional coordination and shared ownership:** during periods of high fine particulate matter concentration in Red Deer, elevated concentrations of varying magnitude at other monitoring stations in Edmonton and Calgary are also typically observed, likely because of large scale meteorological events. As a result of the multi-station occurrence and complexity of the issue, regional coordination through shared ownership in the form of engagement and participation from all relevant stakeholders will help to maintain and improve air quality in the area.
- **Science-based:** effective management actions that will lead to measureable reductions in fine particulate matter concentration must be identified based on best available knowledge and investigative findings of sources. Understanding the conditions and contributions from sources promotes refinement of solutions to the issue.
- **Adaptive management:** the Response at the time of publication reflects the current knowledge and understanding of the issue. Through continuous commitment to further advancing knowledge and understanding of the issue, it is expected that management decisions will also be refined and updated. This adaptive management process, which uses new information to inform management decisions, is an iterative process.
- **Continuous improvement:** similar to an iterative process, the principle of continuous improvement is about actively considering remedial and preventative actions. Stakeholders may use improved technologies and methods to reduce emissions from anthropogenic sources towards the long-term goal of reducing overall ambient concentration of fine particulate matter.
- **Accountability:** through the reporting and evaluation process outlined in the Response, the Red Deer Advisory Committee will meet on a quarterly basis to ensure management actions are implemented. A status report on progress of implementation will be shared publically every three years and evaluation of the Response will occur every five years.



Phase 1		Phase 2		Phase 3	
2015	2020	2025	2030		
Phase 1 Outcomes - what we hope to achieve in Phase 1 by implementing actions identified in:		Phase 2 Outcomes - what we hope to achieve in Phase 2 by implementing actions identified in:		Phase 3 Outcomes - what we hope to achieve in Phase 3 by implementing actions identified in:	
<ul style="list-style-type: none"> Objective 1: action Objective 2: investigation Objective 3: engagement 		<ul style="list-style-type: none"> Objective 1: action Objective 2: investigation Objective 3: engagement 		<ul style="list-style-type: none"> Objective 1: action Objective 2: investigation Objective 3: engagement 	
Reporting		Reporting		Reporting	
2018 Progress Report		2023 Progress Report		2028 Progress Report	
Evaluation		Evaluation		Evaluation	
Five Year Evaluation		Five Year Evaluation			

Figure 7: The Red Deer Fine Particulate Matter Response Logic Model: Understanding and Evaluating a Complex System

THE RESPONSE

Using the logic model systems thinking approach shown in Figure 7, this section bring together knowledge of the key sources and pressures within the Red Deer air quality management area, and feedback from stakeholders, including the public, learnings from other jurisdictions, and scientific findings to develop the Response. Components of the Response include the goal, objectives, outcomes, management actions, reporting, and evaluation criteria sections.

Achieving the goal of the Response requires a proactive and future-focused approach. To achieve this, three main objectives were chosen to recognize the importance of educating (engagement), researching (investigation), and adapting to new information to make informed management actions (action).

Acknowledging that this issue is complex and management actions may take several years before the effect of the actions may be realized, implementation will occur in phases which allows for an iterative process for achieving outcomes and the increasingly more stringent CAAQS for fine particulate matter. Outcomes were identified for the goal and objectives within each phase to realistically describe where we see ourselves and what we hope to achieve within each phase. Consequently, each phase will focus on implementing the identified management actions to ensure the outcomes and goal is met.

Part of implementation is reporting to the public on the progress of implementation, which will occur every three years into each phase and an overall evaluation of the Response will occur at the end of each phase or every five years.

Each component of the Response – the goal, objectives, outcomes, reporting to the public, and evaluation – are described in detail below.

GOAL

The Response was triggered by the CWS however, with CAAQS to be implemented in 2015, the intention of the Response is to manage and reduce ambient fine particulate matter concentration within the defined air quality management area and to measure the effort against the numerical CAAQS at ambient air quality monitoring stations within the Red Deer air quality management area. Therefore the goal of the Response is to:

Reduce ambient fine particulate matter concentration and remain below the numerical CAAQS as measured at ambient air quality monitoring stations within the Red Deer air quality management area.

OBJECTIVES

In order to achieve the goal, three objectives were chosen. All three objectives are essential during each phase of implementation and are not specified according to priority. Each objective interacts with each other and collectively supports achievement of the goal and outcomes of the Response.

OBJECTIVE 1 – ACTION

Identify and develop management actions that can be implemented throughout the year to achieve measurable reductions in ambient fine particulate matter concentrations and precursors.

OBJECTIVE 2 – INVESTIGATION

Continue to improve knowledge of fine particulate matter in the Red Deer air quality management area. Improvement in knowledge can inform the cause of the exceedances and provide insight into better managing the issue.

OBJECTIVE 3 – ENGAGEMENT

Empower the public and stakeholders to reduce ambient fine particulate matter through promotion of outreach and education on the state of air quality in the Red Deer air quality management area and on how they can take action.

IMPLEMENTATION PHASES

Implementation of the management actions identified in the Response will occur in three phases. Table 2 highlights the implementation phases as being aligned with when CAAQS is anticipated to become more stringent. The need for phased implementation of the Response addresses the fact that developing and implementing management actions is complex and may take several years before some actions can be implemented or the effects of the actions to be realized. This approach acknowledges the principle of continuous improvement to ensure ambient concentrations of fine particulate matter continue to remain below the national standards.

Table 2: Red Deer Fine Particulate Matter Response Implementation Phases

Phases	
Phase 1	2015 – 2020
Phase 2	2020 – 2025
Phase 3	2025 – 2030

OUTCOMES

Outcomes were identified in order to set reasonable targets for where we hope to see ourselves and what we expect to achieve within each phase as a result of implementing the management actions listed in Table 5. Table 3 shows the outcomes for the goal and objectives for each phase of implementation of the Response. Establishing outcomes will inform overall evaluation of the Response. For more information on Alberta's transition to managing to the CAAQS in the Red Deer Air Zone, refer to the accompanying GoA Action Plan.

Table 3: Red Deer Fine Particulate Matter Response Outcomes by Objective and Phase

Phase 1 (Underway – 2020)	Phase 2 (2020–2025)	Phase 3 (2025 – 2030)
Goal		
Reduce ambient fine particulate matter concentration and remain below the numerical Canadian Ambient Air Quality Standards (2015 CAAQS) within the Red Deer air quality management area as measured at the monitoring stations.	Reduce ambient fine particulate matter concentration and remain below the numerical Canadian Ambient Air Quality Standards (2020 CAAQS) within the Red Deer air quality management area as measured at the monitoring stations.	Reduce ambient fine particulate matter concentration and remain the numerical below Canadian Ambient Air Quality Standards (2025 CAAQS) within the Red Deer air quality management area as measured at the monitoring stations.
Objective 1: Action		
Phase 1 committed and proposed actions are implemented. Implemented actions will be refined based on new information.	Phase 2 committed and proposed actions are implemented. Implemented actions will be refined based on new information.	Phase 3 committed and proposed actions are implemented. Implemented actions will be refined based on new information.
Objective 2: Investigation		
Government of Alberta and stakeholders including the public increases their knowledge of the conditions, factors, and sources that contribute to the event days observed during the winter months and issues related to year-round management of PM _{2.5} .	Government of Alberta and stakeholders including the public continue to increase their knowledge of the conditions, factors, and sources that contribute to the event days observed during the winter months and issues related to year-round management of PM _{2.5} .	Government of Alberta and stakeholders including the public are knowledgeable of the conditions, factors, and sources that contribute to the event days observed during the winter months and issues related to year-round management of PM _{2.5} .
Objective 3: Engagement		
Stakeholders including the public are aware about the fine particulate matter issue and begin applying their knowledge to take action to address the event days observed during the winter months and issues related to year-round management of PM _{2.5} .	Stakeholders including the public apply their knowledge to changing their attitudes to take meaningful actions to address the event days observed during the winter months and issues related to year-round management of PM _{2.5} .	Stakeholders including the public take meaningful actions to address the event days observed during the winter months and issues related to year-round management of PM _{2.5} .

MANAGEMENT ACTIONS

Based on the current information and understanding about key sectors and pressures within the Red Deer air quality management area, Alberta Environment and Parks and the Advisory Committee members compiled an inventory of management actions to contribute to the overall management of fine particulate matter in the Red Deer air quality management area as documented in Table 5. The list of actions identifies management actions by Alberta Environment and Parks and the Advisory Committee that directly or indirectly manage fine particulate matter or precursor gases within the Red Deer air quality management area based on:

- Committed to: what is currently being done or actions that are not yet happening, but are budgeted for and approved.
- Proposed: Actions that stakeholders are considering, but have not received budget or been approved.

Table 4 defines the terms used for each column in Table 5.

Table 4: Key terms and definitions used in organizing the management actions as shown in Table 5

Definitions	
Sector	The economic sectors identified to be potential contributors to the fine particulate matter issue. Ongoing investigative efforts regarding the relative contribution of the source sectors will help provide additional information to prioritize management efforts. Further details on the rationale for considering these sectors in the Response are outlined in Appendix C.
Timeframe	When the identified management action is expected to begin implementation. <ul style="list-style-type: none"> ▪ Ongoing: current and active management actions that have been implemented before the official implementation of the Response ▪ Underway: management actions that were being implemented during the development of the Response ▪ Phase 1: identified management actions in the Response to begin implementation in 2015 ▪ Phase 2: identified management actions in the Response to begin implementation in 2020 ▪ Phase 3: identified management actions in the Response to begin implementation in 2025
Action	Management action identified that are expected to directly or indirectly result in the reduction of fine particulate matter and precursors.
Lead	Lead(s) are responsible for ensuring successful implementation and reporting back to the Advisory Committee on progress of the management action.
Status	<p>Committed: Management Actions that are -</p> <ol style="list-style-type: none"> a. Already implemented and currently happening b. Not yet happening but are budgeted and approved <p>Proposed: Management actions that are not yet happening and have not been budgeted or approved but are being considered for implementation.</p>

The management actions are organized by objective and by common strategies. Associated with each management action are the lead, status of the action, and the timeframe which correspond to the implementation phases to show when the action is expected to begin implementation.

The action list (Table 5) is not intended to be exhaustive. Instead, it is to provide the baseline and a clear picture of what key stakeholders in the Red Deer air quality management area are currently doing and proposing to do manage fine particulate matter. Others in the Red Deer air quality management area can consider these examples and identify where further actions could be helpful. In future iterations of the Response, through ongoing investigation, reporting to the public, and evaluation of the Response, the management actions list will be refined and additional management actions will be identified and implemented, as applicable.

Appendix D identifies and lists proposed management actions without Lead organized by objective and sector. The management actions in Appendix D are considered as 'proposed new management actions' and were generated by the broader stakeholders during discussion at the January 2015 information workshop and throughout the development of the Response by the Advisory Committee members. The intent of Appendix D is to document the ideas generated throughout the development process to encourage other stakeholders within the Red Deer air quality management area to adopt and adapt the examples during implementation of the Response.

Table 5: Committed and Proposed Management Actions by Alberta Environment and Parks and the Advisory Committee

OBJECTIVE 1: ACTION				
Sector	Timeframe	Action	Lead	Status
Transportation and Energy	Reduce Fuel Consumption			
	Underway to Phase 1	Implement areas of identified change including engagement of Councillor's and staff, vehicle fuel consumption, facilities, and new initiatives to create improvement.	Lacombe County	Proposed
Transportation	Reduce Fuel Consumption			
	Underway	Evaluate fuel consumption of vehicle and machinery fleet, including identifying energy conservation measures that will help lower the operating costs and decrease the environmental impacts of the fleet.	Lacombe County	Committed
	Underway	Develop and implement an internal idle reduction program for the County; includes the County vehicles, machinery, Councillors, and staff.	Lacombe County	Committed
	Underway	Idle Free program launched in the community which includes a large range of education materials, marketing and advertising tools, prompts, and signage posted in key locations in the community. Sign locations include city facilities, recreation and arts centres, City Hall, Red Deer College, businesses, churches, and others.	City of Red Deer	Committed
	Underway	Idle Free School program: Education program around the benefits of being an idle-free school. Program includes teachers' manual, school assembly presentation, communications support, and signage (signage is co-sponsored with partner Lafarge Canada).	City of Red Deer	Committed
	Underway	Greening the Fleet Strategy for the City of Red Deer	City of Red Deer	Committed
	Phase 1	Anti-idling signs are posted at drop-off locations at Red Deer Regional Hospital (completed). This example could be extended to other AHS buildings in the Red Deer area/region (proposed).	Alberta Health Services	Committed and Proposed

Transportation	Phase 1 (2017)	Design and construct two remote shops (one in the east end of the County, one in the west end of the County) to increase operational efficiencies and reduce travel time.	Lacombe County	Committed
	Reduce Emissions with Proper Vehicle Management, Maintenance, and Technology			
	Underway	Lacombe County and Sylvan Lake have started pilot projects to reduce idling times to reduce health and environmental effects. Throughout the project, PAMZ will document and evaluate the process and use the learnings to develop an idle reduction tool kit that other municipalities can use in central Alberta.	Lacombe County	Committed
	Underway	City of Red Deer adopted and is implementing a greening the fleet strategy for corporate vehicles. Red Deer also has a corporate idle free policy for fleet.	City of Red Deer	Committed
	Underway	Dust Control Incentive Program: offer a cost share incentive program to County residents for the purchase and application of dust abatement in front of their residence.	Red Deer County	Committed
	Underway	Improve fleet maintenance through an Integrated Asset Management Plan	Red Deer County	Committed
	Underway	Regional transit services: "BOLT" regional transit service launched as a partnership with Lacombe, Blackfalds, and the City of Red Deer. Regional Transit service between Red Deer County and the City of Red Deer successfully operating.	Various municipalities	Committed
	Underway to Phase 1 (2017+)	Fleet has practical idling procedures in place, while not negatively effecting operational efficiencies; vehicle replacement ensures current advanced emissions systems and technology, and ensures maintenance programs are current.	Lacombe County	Committed
	Phase 1	The use of plug-in interior vehicle warmers in Lacombe County vehicles could be explored and introduced where applicable.	Lacombe County	Proposed
	Phase 1	Could consider writing key elements/ requirements into RFP and RFT for projects provided they are consistent with internal trade agreements and Alberta Purchasing Connection.	Lacombe County	Proposed

Transportation	Create Environments that Encourage Alternative Modes of Transportation			
	Underway	Design and construction of multi-use trails within rural areas, allowing connection to adjoining municipalities.	Lacombe County	Committed
	Underway	Almost all development is low density and does not provide an opportunity to consider public transportation. Currently cooperating with urban centres to provide transportation related to special needs.	Lacombe County	Committed
	Underway	Installation, maintenance, and planning for extensive trail system including walking and biking paths.	City of Red Deer	Committed
	Underway	Construction and maintenance of rural trail systems as well as planning for future expansion of trails through open space and concept planning	Red Deer County	Committed
	Underway	Work with the City of Red Deer to provide RDT service extensions to Gasoline Alley and the Hamlet of Springbrook.	Red Deer County	Committed
	Underway	Continued investigation in the area of waste-to-energy technologies to reduce our need to transport solid waste to landfill outside of the County.	Red Deer County	Committed
	Underway	City of Red Deer providing and considering new transit programs to improve rider services, such as Google Maps and allowing pets on buses. Also to reduce impact by purchasing right-sized buses.	City of Red Deer	Committed
	Underway	Provide support and guidance to assist municipalities when making decisions on land-use planning for improved environmental outcomes.	Alberta Environment and Parks	Committed
Energy	Reduce Energy Consumption			
	Underway	Evaluate energy consumption of facilities, including identifying energy conservation measures that will help lower the operating costs and decrease the environmental impacts of the buildings.	Lacombe County	Committed
	Underway	Consider alternative energy sources (solar power) during the design and construction of two remote shops. Based on the experience gained, solar power may be expanded to other facilities.	Lacombe County	Committed
	Underway	LED traffic light and street light replacement program.	City of Red Deer	Committed

Energy	Underway	Increase Green Power for corporate building as well as working with the community to increase community awareness of green power alternatives.	City of Red Deer	Committed	
	Underway	For internal purchases, will continue to look at energy efficiency when purchasing equipment and vehicles.	Lacombe County	Committed	
	Phase 1	Can amend standards and specifications to require any new generator being proposed as part of a communal water/wastewater facility to be natural gas generated.	Lacombe County	Proposed	
	Phase 1 (2018+)	LED Street Light Replacement Program.	Lacombe County	Proposed	
	Land-use Bylaw Amendment				
Underway	Amendment made to Red Deer County Land-use Bylaw to allow for green energy development.	Red Deer County	Committed		
Industrial	Ensure facilities meet regulatory requirements for fine particulate matter emissions and precursors				
	Underway – Phase 1	Develop and deliver an Air Emissions Management Program focusing on EPEA approval holders in the Red Deer area to manage and reduce emissions for fine particulate matter and its precursors.	Alberta Environment and Parks	Committed	
	Underway	The Alberta Energy Regulator regulates upstream oil and gas facilities within the Red Deer Air Quality Management Area; where these facilities are known to emit NO _x , SO ₂ , and VOCs. Existing requirements, such as Directive 060 are already in place. Collaborate with Environment and Parks in implementation of the Response.	Alberta Energy Regulator	Committed	
	Underway	Reducing NO _x emissions from existing equipment. Major capital expenditures provide the most efficient opportunity to upgrade emission controls and will reduce emission intensity. These opportunities are tied to capital stock turnover timing and major expansions.	NOVA	Committed and Proposed	
Underway	Will continue to look at ways to minimize emissions from owned facilities.	Lacombe County	Committed		

Reduction and Control of Fugitive Emissions			
	Underway	Annual Leak Detection and Repair Program for Fugitive Emissions. Lead industries have a longstanding fugitive emissions control program. Lead industry is defined as the industry responsible for reporting back on the committed management action. At the Advisory Committee table, this currently although subject to change, includes Husky Energy, Shell Canada, NOVA Chemicals, Dow Chemical Canada ULC, MEGlobal Canada Inc.	Lead Industry Committed
Residential			
Reduce fine particulate matter emissions and precursors			
	Phase 1	Alberta Health Services and AEP to collaborate and develop specific messaging for when air quality advisories are issued to encourage public action. Part of developing specific messaging can be informed by the current work to analyze and draw draft findings around fine particulate matter events and health impacts to Albertans.	Alberta Health Services Alberta Environment and Parks Proposed
	Phase 1	During high Air Quality Health Index days driven by fine particulate matter, AEP will work with municipalities to address burning. Part of this initiative will heavily focus on education to inform the public about the effect and impact of wood fire/garbage/yard waste burning on air quality. Additional initiatives can include: <ul style="list-style-type: none"> ▪ Wood burning complaint forms ▪ Free yard waste pick up during spring, summer, and fall ▪ Brushing and chipping program to decrease burning 	Alberta Environment and Parks Proposed
	Phase 1	Can consider a guideline for southern exposure as part of the MDP review. Lacombe County does not have the expertise to develop guidelines and best practices for construction and renovation of homes however can facilitate the dissemination of information available through industry.	Lacombe County Proposed

Objective 2 - Investigation				
Sector	Timeframe	Action	Lead	Status
All	Monitoring and Data			
	Underway	City of Red Deer partners with PAMZ to host monitoring stations at two permanent locations within city limits and regularly reviews and shares data.	City of Red Deer Parkland Airshed Management Zone	Committed
	Underway	Track and report annually to City Council and public on PM _{2.5} and other pollutant level as part of the City of Red Deer's Environmental Master Plan annual reports.	City of Red Deer	Committed
	Phase 1	Review the programs and initiatives being done by neighbouring communities and stakeholders (idle free, carpool, LED lighting)	Red Deer County	Proposed
	Phase 1	<p>Advancing the knowledge of fine particulate matter and its precursors to inform management actions in the Red Deer air quality management area:</p> <ul style="list-style-type: none"> ▪ Increase understanding of the species composition of particulate matter ▪ Broadening the understanding of the spatial and temporal variation of fine particulate matter and its precursors ▪ Continued modelling studies to understand the formation, dispersion and deposition of particulate matter in the region. ▪ Conduct a monitoring network assessment, as required to better design a monitoring program to better understand the sources of fine particulate matter and its precursors. ▪ Investigate other sources of fine particulate matter and its precursors from non EPEA-approved small businesses and operations <p>For more information on Alberta's transition to managing to the CAAQS for fine particulate matter, refer to the accompanying GoA Action Plan.</p>	Parkland Airshed Management Zone Alberta Environment and Parks Alberta Environmental Monitoring, Evaluation and Reporting Agency	Proposed
Transportation and Energy	Understand Impacts			
	Underway	Support carpool promotion programs (for employees, for residents, for customers).	City of Red Deer	Committed
	Underway	Integrated Transportation/Movement Study encouraging public transit and increased multi-use trails.	City of Red Deer	Committed

Transportation and Energy	Underway to Phase 1 (2015)	Understand Lacombe County's impact on the environment regarding energy consumption; includes energy audits of vehicle fuel consumption, energy audit of facilities, identification of current best management practices, and Councillor and staff engagement.	Lacombe County	Committed
	Phase 1	Traffic Light optimization based modelled traffic flow, update model with real time data.	City of Red Deer	Proposed
	Identify Areas for Change			
	Underway to Phase 1 (2016)	Identify potential areas for change around vehicle fuel consumption, facilities, best management practices, alternative energy sources, and engagement of Councillor and staff.	Lacombe County	Proposed
	Phase 1	Improvements to fleet operations and maintenance by reviewing policy.	Red Deer County	Proposed
	Phase 1	Include air quality awareness as part of our tendering packages to promote air quality stewardship with our contractors.	Red Deer County	Proposed
Small Businesses and Operations	Understand impacts			
	Phase 1	Better understand contributions from small businesses and manufacturing that do not require an Environmental Protection and Enhancement Act (EPEA) approval to the fine particulate matter issue. This knowledge will inform us on the impact on air quality and help us identify partners and promote collaborations.	Alberta Environment and Parks	Proposed
	Phase 1	Assist in the dissemination of information relative to emissions from small businesses	Lacombe County	Proposed
	Phase 1	Collaborate in the identification of industry and businesses that are large emitters of air pollution through the planning and environmental department.	Lacombe County	Proposed
Residential	Understand impacts			
	Underway	Gather statistics on the number of patients that present with respiratory related illnesses to Red Deer Emergency Department of Health Link calls. Overlap with air quality data.	Alberta Health Services	Committed

	Phase 1	Investigate the development of guidelines or recommended best practices for new construction to address building energy intensity for both new construction and potentially for renovation of older buildings as well.	City of Red Deer	Proposed
Objective 3 - Engagement				
Sector	Timeframe	Action	Lead	Status
All	Communicate and Promote Responsible Actions to Reduce Fine Particulate Matter Event Days			
	Ongoing	AEP will engage with municipalities to inform and provide support for implementation of the Response.	Alberta Environment and Parks	Committed
	Ongoing	Use of Air Quality Health Index as a public and health care education communications tool.	Alberta Environment and Parks	Committed
	Underway	Develop and implement a PM2.5 Education and Engagement Strategy that identifies target audiences, strategies, and outline best practices for each sector.	All stakeholders	Committed
	Phase 1	Increase public knowledge about air quality. Have link to AEP website or specific information on AHS website and information available through Health Link.	Alberta Health Services	Proposed
	Phase 1	Educate residents on PM2.5 through County News, website, and social media.	Red Deer County	Proposed
	Phase 1	Become a member of PAMZ.	Red Deer County	Proposed
Transportation	Communicate and Promote Responsible Actions to Reduce Air Emissions			
	Underway	Provide Councillors, staffs and the community with education and awareness about idling.	Lacombe County	Committed
	Underway	Engage additional schools into the Idle Free program. There are 16 schools within the City and two in the region that have successfully used the program and been designated as Idle Free. Summer interns are hired to conduct idle free education and observations/audits and research reports.	City of Red Deer	Committed

Transportation	Underway	Recognition and celebration of World Car Free Day aims to reduce car dependency, ultimately reducing air pollution by encouraging residents to leave their car at home and find alternative ways to get around. This has included the City of Red Deer offering free transit services for the entire day as a method to encourage ridership.	City of Red Deer	Committed
	Underway	Facility Idle Free Education Program: Signs are installed across NOVA Chemicals Joffre site to encourage anti-idling for both personal and fleet vehicles.	NOVA Chemicals	Committed
	Underway	NOVA Chemicals uses carpool.ca to allow carpoolers to find carpool partners. Initiatives are held annually to promote carpooling.	NOVA Chemicals	Committed
	Underway	Voluntary Vehicle Emission Testing Program – NOVA Chemicals own equipment to test vehicle emissions and supports vehicle emission testing programs for its employees, community, and in partnership with PAMZ in Red Deer. Emission clinics educate people on vehicle maintenance and the impact of their vehicle on the environment.	NOVA Chemicals	Committed
	Phase 1	During voluntary vehicle emissions testing events, educate about the impact on air quality from altering a vehicle's air emissions control system. Potential to expand service and education to partners (i.e. vehicle dealerships)	Parkland Airshed Management Zone	Committed
	Phase 1	Education brochures on anti-idling for schools to include in beginning of year information packages.	Alberta Health Services	Proposed
Energy	Communicate and Promote Responsible Actions to Reduce Energy			
	Underway	Provide Councillors, staff, and the community with education and awareness about energy consumption.	Lacombe County	Committed
Industrial	Report on continuous improvements related to fine particulate matter			
	Underway	Share a list of improvements implemented by industry that impact and manages for fine particulate matter. Update the list periodically. The intent is to give industry the opportunity to demonstrate continuous improvement and proactive management by publically share what management initiatives have already been implemented.	Lead Industry	Proposed

	Communicate and Promote Responsible Actions to Reduce Fine Particulate Matter Event Days			
Residential/ Others	Phase 1	Give air quality presentations for health care professionals.	Alberta Health Services	Proposed

EDUCATION AND ENGAGEMENT STRATEGY

Collaborative planning and decision-making are central to the legitimacy and effectiveness of public policy and programs. Air quality management is multi-faceted requiring the participation of numerous affected people, industries, and agencies. By combining efforts and working together, stakeholders will achieve a better understanding of local priorities, needs, and expectations as well as broader appreciation of current research, trends, and potential solutions.

The Education and Engagement Strategy is intended to coordinate outreach and education efforts to empower the public and stakeholders to reduce ambient fine particulate matter by informing them on the state of air quality in the Red Deer air quality management area, on how it impacts them, and on what they can do to help.

Using a logic model approach, the strategy is being developed by Alberta Environment and Parks with strategic advice from Parkland Airshed Management Zone Communications Committee and the Red Deer Advisory Committee. The Education and Engagement Strategy is a living document that will be revised and refined as new information is made available during implementation. Alberta Environment and Parks will lead the implementation of the Education and Engagement Strategy in collaboration with the Advisory Committee members.

As shown in Figure 8, the Strategy identifies who could contribute to the achievement of the goal (target audiences), how each sector can contribute, what role they play in developing the literacy outcomes, how the desired outcomes will be effectively and efficiently achieved given the current situation, available resources, and priorities.

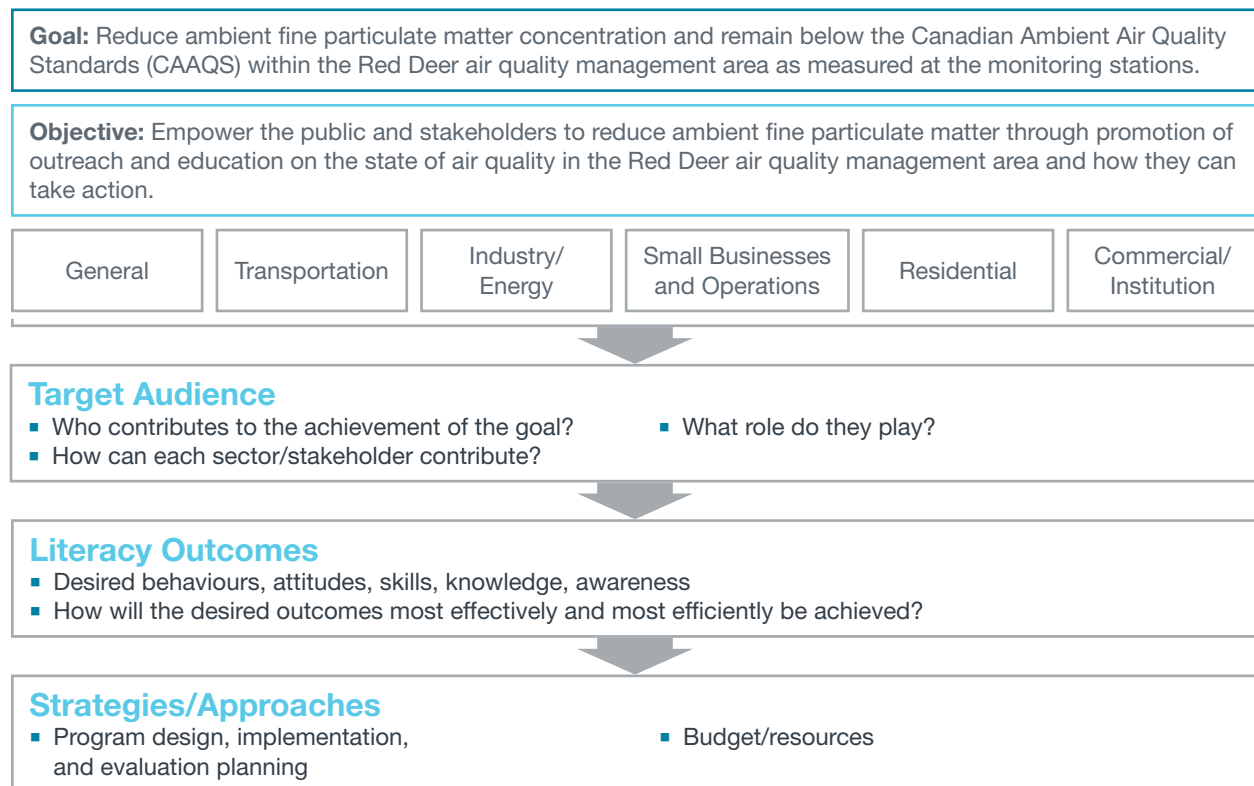


Figure 8: The Red Deer Fine Particulate Matter Response Education and Engagement Strategy Logic Model

From the feedback gathered during the development of the Education and Engagement Strategy, five priority areas of work were identified for implementation with recommended strategies and approaches as outlined in Table 6.

Table 6: The Red Deer Fine Particulate Matter Response Education and Engagement Strategy Logic Model

Priority Area of Work	Strategies and Approach
General Air Quality Education and Outreach	<ul style="list-style-type: none"> ▪ Partner with other department and agencies including Alberta Health Services ▪ Leverage special events like Clean Air Day ▪ Strategic, coordinated public communication and outreach on air quality event days ▪ Create visual, innovative, attention grabbing demonstrations and display to make air quality issues ‘come to life’ ▪ Targeted publications for school audiences, agricultural sector, small businesses, etc. that include key options for taking action ▪ Potential to align with one simple act for air quality ▪ Expand and enhance voluntary vehicle emissions testing clinics
Mobile Source Education	<ul style="list-style-type: none"> ▪ Expand PAMZ Idle Free Campaign to broader audience ▪ Partner with Alberta Health Services and engage other provincial departments and agencies including Department of Transportation for opportunities to promote and enhance idle free, vehicle emissions testing and advanced non-point source emissions management
Promoting Industrial Excellence	<ul style="list-style-type: none"> ▪ Identify best practices for large and small industry ▪ Work with chambers of commerce and Alberta Innovate & Advanced Education for small industry and small operations ▪ Enhance and expand on Action HERO award ▪ Communicate and celebrate industrial achievement in accomplishing continual improvement plans ▪ Engage and align with Climate Change secretariat and GOA ministries on development of incentive programs
Promoting Municipal Excellence	<ul style="list-style-type: none"> ▪ Enhance and expand on Action HERO award ▪ Work one-on-one with municipalities to explore options, transportation strategies and infrastructure, develop strategic planning processes to factor in environmental outcomes ▪ Facilitate collaboration, networking, and communication between municipalities to share successes and create partnerships ▪ Engage on organization similar to the ALIDP (Alberta Low Impact Development Partnership) but for air quality management
Energy Education	<ul style="list-style-type: none"> ▪ Align with Climate Change Strategy implementation and One Simple Act program

PROGRESS REPORT

Following issuance of the Response, the Advisory Committee will continue to meet quarterly to share updates and progress on implemented actions and to ensure the forum exist for accountability, collaboration, and transparent administration. Reporting to the public will occur three years into each phase of implementation. The intent is to share a progress update, identify new management actions, and reflect on what can be improved for the next phase of implementation.

The progress on implementation will be publically reported and will speak to:

- Progress on implementation of management actions, investigation, and engagement;
- Highlight findings from ongoing investigative work;
- Acknowledge other national and provincial initiatives that might also have an impact on the goal of the Response;
- Outline any trends in fine particulate matter in light of the most recent and past air quality annual assessments with respect to meteorology;
- Note any changes to the population and economy within the air quality management area; and
- Identify what worked and what can be improved upon.

EVALUATION

Effectiveness of the Response in reaching its goal will be evaluated every five years, which corresponds to the end and beginning of implementation phases.

The intent of the five year evaluation period is to assess whether the management actions being implemented in each phase are effective in meeting the goal and outcomes of the Response. As part of evaluation, the Response and Science Report will also be comprehensively reviewed for the purpose of applying adaptive management, incorporating new scientific findings, acknowledging new stresses on the environment, and aligning with provincial and national initiatives. The review will serve to update the documents and to incorporate new information.

It is important to acknowledge that there are obvious challenges to making the causation link between the management actions being implemented in the Response to the ambient fine particulate matter concentration as measured at the monitoring stations. However, by identifying indicators to assess the ambient conditions, the frequency and magnitude of the events observed, the expected emissions reduction where applicable, and outcomes; we can expect that if our actions are effective, then the indicators outlined in Table 7 will demonstrate actions are having the intended impact on improving air quality in the area.

By working through the implementation of the management actions, committing to increasing our general and scientific knowledge of the issue, ensuring transparent reporting back to the public on progress, and evaluating the Response using indicators, Alberta Environment and Parks in collaboration with stakeholders will be able to inform management decisions that are based on the best available information.

Table 7: Proposed indicators for evaluating the Red Deer Fine Particulate Matter Response

Proposed Indicators	What is it measuring?	Rationale
Canadian Ambient Air Quality Standards (CAAQS)	Ambient fine particulate matter concentration	If the implemented management actions are effective then we can expect to see a reduction in ambient fine particulate matter concentration.
Event Days	Frequency and magnitude	If the implemented management actions are effective then we can expect to see a reduction in the number of event days reported.
Emission Reduction	The estimated reduction in precursor emissions as a result of implementing management actions identified in the Response.	Efforts will be made to quantify the estimated reduction in precursor emissions, where feasible from implementing management actions.
Outcomes	The implementation targets are achieved.	Evaluate whether targets are met in each implementation phase by Objective.

NEXT STEPS

Implementation will continue to focus on delivery of the management actions and initiatives specified under each of the three objectives. For Phase One, the priorities for Alberta Environment and Parks are:

OBJECTIVE 1 – ACTIONS

- Implement and develop Phase One committed and proposed management actions.

OBJECTIVE 2 – INVESTIGATION

- Refine scientific knowledge of the issue through speciation monitoring and source apportionment modeling.

OBJECTIVE 3 – ENGAGEMENT

- Implement the Education and Engagement Strategy.
- Continue the Advisory Committee process with quarterly meetings to begin reporting on and tracking progress of implemented management actions.

SUMMARY – HOW IT ALL FITS TOGETHER

The Government of Alberta recognizes the importance of air quality and is committed to leading the implementation of the Response. The complexity of the fine particulate matter issue highlights how all stakeholders and sectors have levers for action and power to influence that complement the Government of Alberta in managing air quality.

Air quality management is complex where all jurisdictions and stakeholders in the Red Deer air quality management area can contribute to the better management of fine particulate matter. The public expects stakeholders to work together to responsibly manage and prevent air quality from deteriorating, and strive for continuous improvements in air quality.

With the 2015 release of the CAAQS results (2011-2013 data) as part of the AQMS, it is important to understand where the Response fits into the overall system. The Response is the first step to delivering on regional air quality management in the Red Deer air quality management area and sets up the regionally collaborative approach to manage the fine particulate matter issue. It recognizes that actions need to continue to be implemented with new actions to be developed over time informed by new information. It also recognizes the need to align with Alberta's transitional approach to managing toward the CAAQS for fine particulate matter. For more information on this transition to CAAQS, refer to the accompanying GoA Action Plan.

Given the complexity of the issue and the multitude of potential sources contributing to the issue, the Response incorporates both regulatory and non-regulatory actions to address point and non-point sources. Regulatory actions fall to the government agencies to implement through facility operating conditions. Non-regulatory actions include information outreach to educate, encourage voluntary undertaking of activities, enable behavioral change, and establish partnerships and agreements between different level of government, stakeholders, and the public. This collaboration between multiple players demonstrates a regionally coordinated approach critical to the success of managing a complex issue and will set the foundation for the regional Red Deer Air Quality Management Framework under the Land-use Framework.

The issue of elevated fine particulate matter concentration will continue to be of importance as the national standards for fine particulate matter and ground-level ozone become more stringent. As a result, the Government of Alberta is exploring a number of possible options to reduce air pollution emissions, including more stringent standards for industry, standards for vehicles, and increased air monitoring. Efforts are being made to learn how jurisdictions in non-attainment of national fine particulate matter standards manage for point and non-point sources. This will inform development of management tools specific to Alberta.

As the Government of Alberta continues to scope out the provincial policy direction and supporting management tools to managing for CAAQS across the Red Deer Air Zone, the current regional work of developing and implementing the Red Deer Fine Particulate Matter Response within the Red Deer Air Quality Management Area will inform provincial policy and planning over the medium and long-term. Alberta Environment and Parks is currently developing an initiative in both the Red Deer and Capital Region air quality management areas. The air emissions management program will focus on EPEA approval holders within Red Deer air quality management area to manage and reduce particulate matter and its precursors. The program will align with Alberta's transition to managing to the CAAQS for fine particulate matter. For more information on the CAAQS, refer to the accompanying GoA Action Plan.

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ABBREVIATIONS AND ACRONYMS

AEMERA	Alberta Environmental Monitoring, Evaluation and Reporting Agency
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AQHI	Air Quality Health Index
AQMS	Air Quality Management System
BLIERS	National base-level industrial emissions requirements
CAAQS	Canadian Ambient Air Quality Standards
CASA	Clean Air Strategic Alliance
CCME	Canadian Council of Ministers of the Environment
CWS	Canada-wide Standard
EPEA	Environmental Protection and Enhancement Act
FDMS	Filter Dynamic Measurement System
FEM	Federal Equivalent Method
LED	Light-emitting Diode
LEEDS	Principles
LiDAR	Light Detection And Ranging
MDP	Municipal Development Plan
NAAQS	National Ambient Air Quality Objectives
NH ₃	Ammonia
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
PAMZ	Parkland Airshed Management Zone
PM ₁₀	Particulate Matter Less than 10 Microns in Diameter
PM _{2.5}	Fine Particulate Matter
QEII	Queen Elizabeth II Highway

RDPS	Regional Deterministic Prediction System
SHARP	Synchronized Hybrid Ambient Real-time Particulate
SO ₂	Sulphur Dioxide
TEOM-SES	Tapered Element Oscillating Microbalance Sample Equivalent System
TSP	Total Suspended Particles
US EPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

GLOSSARY

Acid Deposition Management Framework

Sulphur dioxide (SO₂) and nitrogen oxides (NO_x) are the main acid-forming pollutants. The Alberta Acid Deposition Management Framework (2008) is based on four levels of acid deposition. Each of the levels of deposition corresponds with specific management practices.

Action Level

An action level is one of four levels of the Clean Air Strategic Alliance Particulate Matter and Ozone Management Framework, e.g., Baseline Monitoring and Data Gathering, Surveillance Actions, Management Plan or Mandatory Plan to Reduce Below the Canada-wide Standards (or Canadian Ambient Air Quality Standards starting in 2015).

Air Quality

The composition of air, with respect to quantities of pollutants therein, and/or a measure of the health-related and visual characteristics of the air; used most frequently in connection with standards against which the contribution of the particular pollutant source can be compared.

Air Quality Management System

The national Air Quality Management System (AQMS) is a comprehensive approach for reducing air pollution in Canada. It is the product of unprecedented collaboration by the federal, provincial, and territorial governments and stakeholders.

Air Quality Objective

A numerical concentration, value, or narrative statement which is intended to provide protection of the environment and human health to the extent that is technically and economically feasible, and is socially and politically acceptable.

Airshed

An airshed is a geographic area that, because of emissions, topography, climate and meteorology, typically experiences similar air quality.

Air Zones

Air zones are a place-based approach to managing local air quality. In Alberta, the air zones assume the regional land-use boundaries with the exception of Lower and Upper Peace being considered as one air zone. Consequently, there are six air zones – Peace (Lower and Upper Peace regions), Lower Athabasca, Upper Athabasca, North Saskatchewan, South Saskatchewan, and Red Deer. Air management can be guided by an Air Zone Management Framework and will be considered in the regional air quality management framework to ensure proactive measures are taken to protect air quality in accordance with the principles of continuous improvement and keeping clean areas clean.

Ambient Air

Outside air; any portion of the atmosphere not confined by walls and a roof to which the general public has access.

Ambient Air Quality Trigger

An ambient air quality trigger is a concentration set at a value lower than the ambient air quality limit. The ambient air quality triggers are intended to provide sufficient time to react to prevent reaching the ambient air quality limit.

Ammonia (NH₃)

A pungent colorless gaseous compound of nitrogen and hydrogen that is very soluble in water and can easily be condensed into a liquid by cooler temperature and pressure.

Approval

Under the Environmental Protection and Enhancement Act (EPEA), “approval” means an approval issued in respect of an activity, and includes the renewal of an approval.

Base-Level Industrial Emissions Requirements (BLIERs)

BLIERs are one component for consideration when developing provincial source emission requirements and industrial approvals; but are not the sole consideration. Alberta, like all other jurisdictions, is entitled to set more stringent requirements especially where the BLIERs do not align with provincial policy. The BLIERs represent minimum national source-based standards.

Canadian Ambient Air Quality Standards

The Canadian Council of Ministers of the Environment is developing Canadian Ambient Air Quality Standards that will be established as objectives under the Canadian Environmental Protection Act (1999), and will replace the existing Canada-wide Standards. These new standards will be developed for particulate matter and ozone first, and then for nitrogen oxides, sulphur dioxide, and volatile organic compounds. The standards will set triggers to promote proactive measures to keep clean areas clean and for continuous improvement.

Canada-wide Standards

Canada-wide Standards are inter-governmental agreements developed under the Canadian Council of Ministers of the Environment to address environmental protection and health risk issues. The standards represent a commitment to reducing the concentrations of substances such as fine particulate matter and ozone in ambient air.

Clean Air Strategic Alliance (CASA)

The Clean Air Strategic Alliance is multi-stakeholder partnership, composed of representatives selected by industry, government, and non-government organizations, which recommends strategies to assess and improve air quality in Alberta.

Continuous Monitoring

Continuous monitoring involves monitoring the quality of the ambient air on a continuous basis. This can provide the greatest resolution but may be costly due to capital and operating expenses. Data from continuous monitoring can be stored in different time blocks, such as one-hour averages or five-minute averages. Typically, fine particulate matter and gases such as ozone and sulphur dioxide are continuously monitored. Continuous monitoring can be carried out on a long-term or temporary basis.

Cumulative Effects

Cumulative effects are the combined effects of past, present, and foreseeable human activities over time on the environment, economy, and society in a particular place. The combination of activities can produce effects that are different in scale, nature, or extent from the effects of individual activities alone.

Emissions Management Framework for the Alberta Electricity Sector

The Clean Air Strategic Alliance (2003) Emissions Management Framework for the Alberta Electricity Sector aims at continuous improvement of air emissions standards for electricity generation through seven key components: standards for new units, requirements for existing units, stakeholder review at five-year intervals, monitoring transparency and accountability, continuous improvement, renewable and alternative energy, and energy efficiency and conservation.

Fine Particulate Matter

Refers to airborne particles that are 2.5 microns or less in diameter.

Fine Particulate Matter Event

“Event days” are those days where the 24-hour average fine particulate matter concentration is equal to or greater than 20 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$); this is equivalent to exceeding the planning trigger into Level 3. The 24-hour concentration is calculated from midnight to midnight. The fine particulate matter concentration of 20 micrograms per cubic meter was adopted from the Management Plan Action Level in the Clean Air Strategic Alliance PM and Ozone Framework.

Industrial Release Limits Policy

The intent of this policy is to provide a clear process for developing industrial release limits that ensures the appropriate level of pollution prevention and control technologies are adopted and that the environment is adequately protected. This involves determining the achievable release limits based on the capability of the most effective demonstrated pollution prevention and control technologies.

Inversions

Also called a thermal inversion, temperature inversions occur when the normal decrease in air temperature with increasing altitude is reversed and air above the ground is warmer than the air below it. With temperature inversions, cold air sinks to the ground level and stays there because it is denser than warm air. The conditions become stagnant and pollutants are trapped at ground level.

Iterative

The process of revising and improving with the aim of approaching a desired goal with each revision.

Nitrogen Dioxide (NO_2)

Toxic pungent reddish-brown gas formed by the reaction of atmospheric ozone with the nitric oxide produced from combustion.

Nitrogen Oxides (NO_x)

A general term pertaining to nitrogen monoxide (NO) and nitrogen dioxide (NO_2). Nitrogen oxides are typically created during combustion processes, and are major contributors to smog formation and acid deposition.

Non-point Source

Non-point source is a pollution source that is not recognized to have a single point of origin. It is often characterized by the release of pollutants from many different and diffuse sources (aggregated sources of emissions). This aggregation is done because the emission sources are either too small and numerous, too geographically dispersed, or too geographically large to be estimated or represented by a single point.

Ozone (O_3)

Refers to an oxygen compound (O_3) occurring in the form of a gas in the atmosphere at ground level.

Passive Monitoring

Passive monitoring involves exposing a reactive surface to the air, which results in transfer of the pollutant by diffusion from the air to the monitor's surface. The exposed surfaces are analyzed to determine the pollutant concentration. The sampling rate for some passive monitors is adjusted based on wind speed, temperature, and humidity.

Point Source

A point source is a stationary location or fixed facility from which substances are discharged.

Primary Pollutant

A primary pollutant is one that is emitted into the atmosphere directly from the source of the pollutant and retains the same chemical form.

Regional Monitoring

Regional stations are strategically located to represent areas with multiple emission sources.

Secondary Pollutant

A secondary pollutant is one that is formed by atmospheric reactions of precursor of primary emissions. Secondary pollutants undergo a chemical change once they reach the atmosphere. An example of a secondary pollutant is ozone created from organic vapours given off at a gasoline station. The organic vapours react with sunlight in the atmosphere to produce the ozone, the primary component of smog. Control of secondary pollutants is generally more problematic than that of primary pollutants, because mitigation of secondary pollutants requires the identification of the precursor compounds and their sources as well as an understanding of the specific chemical reactions that result in the formation of the secondary pollutants.

Source Apportionment

This is a process of taking measurements and tracking down the sources of a substance through receptor modelling, which helps in identifying the sources and the extent of contribution to the substance.

Source (of Emissions)

There are many sources of emissions, but these have generally been grouped into two categories: emissions from point and non-point sources. A point source is a stationary location or fixed facility from which substances are discharged. A non-point source is a pollution source that is not recognized to have a single point of origin. Common non-point emission sources are agriculture, forestry, urban, mining, construction, and city streets.

Sulphur Dioxide (SO₂)

A strong smelling, colourless gas that is formed by the combustion of fossil fuels containing sulphur. Sour gas processing plants, oil sands processing plants, and coal-fired power generating plants are major sources of sulphur dioxide.

Volatile Organic Compounds (VOCs)

VOCs are carbon-containing compounds that evaporate into the air at room temperature. VOCs contribute to the formation of smog and/or may be toxic. Common sources include gasoline, alcohol, and the solvents used in paints.

APPENDIX A: AIR QUALITY MANAGEMENT IN ALBERTA

Air quality management in Alberta has evolved over time to adapt to changing needs and improved knowledge and can be traced back to 1945 when a section of Alberta's *Public Health Act* was amended to follow the evaluation of air quality complaints. Alberta's Department of Health was responsible for programs to assess and control air pollution in Alberta until 1971, when Canada's first environment department, the Alberta Department of Environment was created. Soon after, Alberta's *Clean Air Act* was passed, which allowed the environment minister to make a range of regulations related to ambient air quality standards, emission standards, and monitoring methods. In 1992, the *Clean Air Act* was replaced with the *Environmental Protection and Enhancement Act*.

Air quality has traditionally been managed for industrial facilities, specific populations, and ecologically sensitive areas through environmental assessments, regulatory approvals, code of practices, and enforcement. Other management approaches for point sources include ambient air quality objectives, source performance standards, plume dispersion modelling, ambient air and source emission monitoring, environmental reporting, emission inventories, compliance education and prevention programs, and research. Point sources are defined as a stationary location or fixed facility from which substances are discharged.

By 2007, with increased population and industrial growth, the Government of Alberta recognized that management of air quality must not only be approached on a project-by-project basis but must also consider a cumulative effects management approach at a regional scale. Comprehensive regional air management was phased in to meet the evolving need to inform and address stakeholders' concerns on local issues, such as public health, impact of new facilities, and regional development. Today, cumulative effects management continues to establish outcomes for an area by balancing environmental, economic, and social considerations and implementing appropriate plans and tools to ensure those outcomes are met. This approach also recognizes the need to develop strategies to manage non-point sources as well as the point sources. Non-point sources are those sources too diverse or widespread to regulate through the traditional approval method. Jurisdictional issues and the number of sources also add to the complexity of regulating and management of non-point sources.

APPENDIX B: ATTENDEES AT THE INFORMATION WORKSHOPS

Organization	Name
Aaron Rongvaldsen	Husky Energy
Andrea Brack	NOVA Chemicals
Andrew Treu	Red Deer County
Barry Bennett	Agrium
Bonnie Denhaan	Parkland Airshed Management Zone/Public Member
Brigette Duniece	Permolex
Cajun Paradis	Lacombe County
Crissy Handziuk	NOVA Chemicals
Colin Hartloper	NOVA Chemicals
David Brand	Town of Sylvan Lake
Ed Williams	Richardson
Elton Lawes	NOVA Chemicals
Fiona Slessor	Alberta Environment and Parks

Jay Williamson	Arc Resources
Jeff Hanger	RDRWA
Jim Gendron	LTG Consulting
Jim Robertson	Waskasoo Environmental Education Society
Jim Saltvold	Parkland Airshed Management Zone/Public Member
John Tchir	Alberta Environment and Parks
Kelly Bauer	Alberta Health Services
Kevin Warren	Parkland Airshed Management Zone/Public Member
Koray Ander	ConocoPhillips
Laura Polasek	Alberta Environment and Parks
Lauren Maris	City of Red Deer
Lisa Avis	Alberta Environment and Parks
Maria Vavro	Alberta Environment and Parks
Mark Maciejewski	Border Paving
Matthew Parsons	Environment Canada
Maxwell Mazur	Alberta Environment and Parks
Mikaela McQuade	Canadian Association of Petroleum Producers
Noor Alif	Alberta Environment and Parks
Pervez Sunderani	Alberta Environment and Parks
Phoenix Le	Alberta Environment and Parks
Randall Barrett	Alberta Environment and Parks
Reg Warkentin	Red Deer Chamber of Commerce
Renata Coderre	Coderre and Company
Rene Michalak	Rethink Red Deer
Robert McBrien	NOVA Chemicals
Robert Pole	Alberta Environment and Parks
Sharina Kennedy	Alberta Environment and Parks
Shelly Morris	Alberta Environmental Monitoring, Evaluation, and Reporting Agency
Steve Quine	MEGlobal Canada Inc.
Sue Arrison	Parkland Airshed Management Zone /Public Member

APPENDIX C: SOURCE SECTORS AND RATIONALE

Sector	Rationale
Transportation	The transportation sector includes all activities that relate to on-road and off-road vehicles. Certain transportation types including aircraft and marine vessels have not been considered as these modes are unlikely to be managed at an airshed level in Alberta. Precursor emissions in on-road and off-road vehicle exhaust may react in the atmosphere to form secondary fine particulate matter. Primary fine particulate matter is emitted through construction operations and unpaved roads. In addition to including policies that impact transportation, infrastructure and land-use play a key role in shaping travel patterns, which are linked to traffic congestion, greenhouse emissions, air pollution, and fuel consumption.
Industrial	The industrial sector includes all activities related to the processing and assembling of raw materials. Precursor emissions from industrial activities such as petroleum refining, chemical production, metal manufacturing, oil and gas extraction, and natural gas use and processing may react in the atmosphere to form secondary fine particulate matter. All industrial activities related to the production and upstream distribution of crude oil, bitumen, coal, and natural gas are covered in this sector. These activities can produce nitrogen oxides and sulphur dioxide emissions which contribute to smog, acid rain, and the formation of fine particulate matter.
Small Businesses and Operations	Some aspect of the upstream oil and gas industries do not require an approval or registration under a code of practice. These types of facilities are the smaller, more common types such as well sites, batteries, compressor stations, and activities such as drilling and completions. Any such activity must conform to ambient air quality objectives. This sector is important as it is a potential non-point source currently not managed through regulations, approvals, or codes of practice.
Residential	The residential sector includes all activities and equipment related to residential buildings including: space heating, water heating, air conditioning, and lighting, refrigeration, cooking, and running a variety of other appliances. This sector is important as it is a potential non-point source currently not managed through regulation, approvals, or codes of practice.
Commercial/Institutional	The commercial and institutional sector includes non-manufacturing business establishments, government, schools, hospitals, and public organizations. This sector is important as it is a potential non-point source currently not managed through regulation, approvals, or codes of practice.

APPENDIX D: PROPOSED NEW MANAGEMENT ACTIONS

Objective 1: Action	
Sector	Action
Residential	Layout new subdivisions so that every lot has southern exposure which can be used for passive solar gain.
	Develop a guideline/recommended best practices for new construction to address building energy intensity applicable to the Red Deer Region.
	Develop a guideline/recommended best practice for renovating older homes focused on energy conservation applicable to the Red Deer Region. Provide home energy audit information, workshops, tools, or supports to resident to assist in reducing energy use.
	Inform new home buyers of the latest and best building practices.
Energy	Restrict the use of diesel generators.
	Incorporate more solar energy into Alberta's energy mix.
	Financial incentives are a valuable tool for encouraging less PM output. Credits/deductions for high efficiency furnaces, efficient vehicles, or for business that update/invest in new equipment that would reduce energy consumption.
	Consider Leadership in Energy & Environmental Design (LEED) principles when replacing a building or roof
Industry	Review facility emissions in affected areas and look for ways to help meet plan objectives.
	Through study, determine the facility regional effects and impacts on NOx and PM2.5. Currently not properly understood.
Transportation	Provide incentives for public transportation.
	Expand the campaign to encourage the use of plug-in interior vehicle warmers as an alternative to idling to warm up the interior. Expand on the literature, diesel technology etc. (ex. Set a time limit on remote starters).
All	Consider key elements/requirements that can be written into RFP and RFT for construction, public works, and environmental services. What can be asked of those who work in service delivery to do better (i.e. age and quality of equipment used)?

Objective 2: Investigation

Sector	Action
Transportation and Energy	Traffic light optimization based modelled traffic flow, update model with real time data.
	Investigate the availability of automatic shutoff and starting devices to reduce idling when (fleet) vehicle is waiting for a traffic signal to change.
	Investigate opportunities to build solar ready for water heating to remove combustion sources.
	Investigate the contribution of secondary fine particulate matter precursor emissions from small engines and off-road vehicles (lawnmowers, leaf blowers, snow blowers, all-terrain vehicles like snowmobile, quads, etc.). Consider programs or incentives that municipalities could offer to reduce contributions from these sources (e.g. other jurisdictions have used partnerships with retailers for trade programs where you can trade in your gas powered mower for a rebate towards an electric or manual one).
	Look into the effectiveness and feasibility of developing parking lots for carpooling and park n' bike.
Small Businesses and Operations	Better understand contributions from small businesses and manufacturing (not regulated through EPEA). This knowledge will help us identify partners and promote collaborations.
	Investigate how stakeholders can identify industries and businesses that are large emitters of air pollution and investigate the tools available to work with them for emission reduction. This knowledge will help identify partners and promote collaboration.

Objective 3: Engagement

Sector	Action
All	Expand public health education around what is PM2.5 and associated health impacts.
	Get everyone (at the meeting) on the PAMZ newsletter list so that the airshed can keep them updated.

