Elbow River at McLean Creek Dam (MC1)
Environmental Impact Screening Report

Sections 8.0 – 12.0

Section 8.0 – Human Environment

Section 9.0 – Planned Development Case

Section 10.0 – Effects of the Environment on the MC1 Option

Section 11.0 – Accidents and Malfunctions

Section 12.0 – Conclusion

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File: 2025-001.01
September 2017

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TABLE OF CONTENTS

8.0 HUMAN ENVIRONMENT 8.1

8.1 LAND USE AND MANAGEMENT 8.1

8.1.1 Scope of Assessment 8.1

8.1.2 Baseline Case 8.8

8.1.3 Application Case 8.36

8.1.4 Follow-up Monitoring for Land Use and Management 8.55

8.1.5 References 8.56

8.2 SOCIO-ECONOMIC RESOURCES 8.61

8.2.1 Scope of Assessment 8.61

8.2.2 Baseline Case 8.67

8.2.3 Application Case 8.81

8.2.4 Follow-up Monitoring for Socio-economic Resources 8.99

8.2.5 References 8.100

8.3 PUBLIC HEALTH AND SAFETY 8.104

8.3.1 Scope of Assessment 8.104

8.3.2 Baseline Case 8.113

8.3.3 Application Case 8.125

8.3.4 Follow-up Monitoring for Public Health and Safety 8.143

8.3.5 References 8.145

9.0 PLANNED DEVELOPMENT CASE 9.1

9.1 SUBSTANTIVE ADVERSE RESIDUAL EFFECTS 9.2

9.2 PROJECT INCLUSION LIST 9.2

9.3 FLUVIAL GEOMORPHOLOGY 9.4

9.4 VEGETATION AND WETLANDS 9.4

9.5 WETLANDS 9.5

9.6 AQUATIC ENVIRONMENT 9.6

9.7 LAND USE AND MANAGEMENT AND INFRASTRUCTURE 9.7

9.8 REFERENCES 9.8

10.0 EFFECTS OF THE ENVIRONMENT ON THE MC1 OPTION 10.1

10.1 PROBABLE MAXIMUM FLOOD 10.1

10.1.1 Description 10.1
10.1.2 Mitigation by Design 10.1
10.2 BEAVER FLATS LANDSLIDE COMPLEX 10.2
10.2.1 Description 10.2
10.2.2 Mitigation by Design 10.3
10.3 REFERENCES 10.4
11.0 ACCIDENTS AND MALFUNCTIONS 11.1
11.1 SCOPE 11.1
11.2 METHODOLOGY 11.2
11.3 SCENARIO 1: EARTHWORKS FAILURE – MAIN DAM 11.4
11.3.1 Overview 11.4
11.3.2 Potential Effects 11.4
11.3.3 MC1 Option Design and Operational Considerations 11.6
11.3.4 Risk Assessment 11.6
11.4 SCENARIO 2: EARTHWORKS FAILURE – COFFERDAM 11.7
11.4.1 Overview 11.7
11.4.2 Potential Effects 11.7
11.4.3 MC1 Option Design and Operational Considerations 11.7
11.4.4 Risk Assessment 11.7
11.5 SCENARIO 3: RELEASE OR SPILLS OF HAZARDOUS MATERIALS 11.8
11.5.1 Overview 11.8
11.5.2 Potential Effects 11.8
11.5.3 MC1 Option Design and Implementation Considerations 11.8
11.5.4 Risk Assessment 11.9
11.6 SCENARIO 4: SEDIMENT CONTROL FAILURE 11.9
11.6.1 Overview 11.9
11.6.2 Potential Effects 11.10
11.6.3 MC1 Option Design and Construction Considerations 11.10
11.6.4 Risk Assessment 11.11
11.7 REFERENCES 11.12
12.0 CONCLUSION 12.1

List of Tables

Table 8.1-1 Summary of Applicable Regulatory and Policy Framework for Land Use and Management 8.1
Table 8.1-2 Valued Components for Land Use and Management 8.3
Table 8.1-3 Measurable Parameters for Land Use and Management 8.3
Table 8.1-4 Spatial Boundary Definitions for Land Use and Management 8.4
Table 8.1-5 Administrative Boundaries in the MC1 Option area and Local Assessment Area 8.9
Table 8.1-6 Land Ownership in the MC1 Option Area and Local Assessment Area 8.10
Table 8.1-7 Existing Dispositions Overlapping with the MC1 Option area 8.14
Table 8.1-8 Disposition Reservations and Notations Overlapping with the MC1 Option area 8.16
Table 8.1-9 Identified Non-motorized Recreational Trails in the Local Assessment Area 8.24
Table 8.1-10 Provincial Recreation Areas in the Local Assessment Area 8.25
Table 8.1-11 Campgrounds in the Local Assessment Area 8.26
Table 8.1-12 2016 General Hunting Regulations in Wildlife Management Unit 406 ..... 8.29
Table 8.1-13 2017 Fishing Regulations Applicable to the Local Assessment Area 8.30
Table 8.1-14 Identification of Potential Option Interactions with Land Use and Management 8.36
Table 8.1-15 Provincial Recreation Areas in the MC1 Option area 8.38
Table 8.1-16 Summary of Potential MC1-related Effects to Resource and Commercial Use Areas 8.40
Table 8.1-17 Summary of Potential Effects and Mitigation Measures for Land Use and Management 8.47
Table 8.1-18 Residual Effects Characteristics for Land Use and Management 8.49
Table 8.1-19 Summary of Effect Characteristics Ratings for Changes to Protected Areas 8.50
Table 8.1-20 Summary of Effect Characteristics Ratings for Changes to Resource and Commercial Uses 8.51
Table 8.1-21 Summary of Effect Characteristics Ratings for Reduction to Recreational Use 8.53
Table 8.1-22 Summary of Effect Characteristics Ratings for Change in Quality of Recreational Experience 8.54
Table 8.1-23 Summary of Effect Characteristics Ratings for Disruption of Infrastructure 8.54
Table 8.2-1 Summary of Applicable Regulatory and Policy Framework for Socio-economic Resources 8.61
Table 8.2-2 Valued Components for Socio-economic Resources 8.63

Table 8.2-3 Measurable Parameters for Socio-economic Resources 8.64
Table 8.2-4 Selected Demographic Characteristics, Age Distribution, and Gender Ratio 8.72
Table 8.2-5 Labour Force Characteristics 8.73
Table 8.2-6 Percent Employment by Industry 8.75
Table 8.2-7 Employment by Occupation 8.76
Table 8.2-8 Individual Income Characteristics 8.76
Table 8.2-9 Source Income 8.77
Table 8.2-10 Highest Educational Attainment for Percentage of Population Aged 15 Years and Over 8.77
Table 8.2-11 Population Mobility of Calgary CMA and Rocky View County Residents 8.78
Table 8.2-12 Kananaskis Improvement District Five-year Operating Budget 8.80
Table 8.2-13 Housing Characteristics of the Regional Assessment Area 8.81
Table 8.2-14 Rental Vacancy Rates in the Calgary Census Metropolitan Area 8.81
Table 8.2-15 Potential Interactions with Socio-economic Resources Valued Component 8.82
Table 8.2-16 Capital Cost Estimates 8.83
Table 8.2-17 Economic Effects of MC1 Capital Expenditures 8.85
Table 8.2-18 Economic Effects of MC1 Operating Expenditures 8.85
Table 8.2-19 Campgrounds Potentially Affected by Construction of MC1 Option 8.89
Table 8.2-20 Summary of Potential Effects and Mitigation Measures for Socio-economic Resources 8.92
Table 8.2-21 Residual Effects Characteristics for Socio-economic Resources 8.93
Table 8.2-22 Summary of Effect Characteristics Ratings for Increases to Provincial and Regional Economies 8.95
Table 8.2-23 Summary of Effect Characteristics Ratings for Change in Labour Force 8.96
Table 8.2-24 Summary of Effect Characteristics Ratings for Change in Contracting and Procurement Opportunities 8.96
Table 8.2-25 Summary of Effect Characteristics Ratings for Change in Economic Activities of Resource-dependent Businesses and Industry 8.97
Table 8.2-26 Summary of Effect Characteristics Ratings for Change to Regional Economic Conditions 8.98
Table 8.2-27 Summary of Effect Characteristics Ratings for Change to Availability of Accommodation 8.99

Table 8.3-1 Summary of Applicable Regulatory and Policy Framework for Public Health and Safety 8.105
Table 8.3-2 Inhalation Exposure Limits for the Protection of Human Health 8.106
Table 8.3-3 Noise Thresholds for the Protection of Human Health 8.107
Table 8.3-4 Valued Components for Public Health and Safety 8.109
Table 8.3-5 Measurable Parameters for Public Health and Safety 8.109
Table 8.3-6 Spatial Boundary Definitions for Public Health and Safety 8.110
Table 8.3-7 Discrete Public Receptor Locations in the Local Assessment Area 8.112
Table 8.3-8 Health Profile Data: Rural West Zone, Calgary Zone, and Alberta 8.116
Table 8.3-9 Health Profile Data: Calgary Zone and Alberta 8.117
Table 8.3-10 Background Air Quality Concentrations at Receptor Locations 8.118
Table 8.3-11 Baseline Sound Levels at Noise Receptors 8.118
Table 8.3-12 Potential Health Effects of Flooding 8.123
Table 8.3-13 Factors that Affect Vulnerability 8.125
Table 8.3-14 Identification of Potential Option Interactions with Public Health and Safety 8.126
Table 8.3-15 Predicted Total Exposure Concentrations at Air Quality Receptor Locations 8.129
Table 8.3-16 Predicted Noise Levels along the Highway Realignment Route 8.132
Table 8.3-17 Predicted Noise Levels at Public Receptor Locations 8.133
Table 8.3-18 Summary of Potential Effects and Mitigation Measures for Public Health and Safety 8.140
Table 8.3-19 Residual Effects Characteristics for Public Health and Safety 8.142
Table 8.3-20 Summary of Effect Characteristics Ratings for Public Health and Safety during Option Operation and Maintenance 8.143
Table 9.2-1 Project Inclusion List[1] 9.3
Table 10.1-1 Peak Flow Estimates for the Elbow River Dam at McLean Creek Option 10.1
Table 11.2-1 Definitions for Likelihood of an Event 11.2
Table 11.2-2 Definitions for Severity of an Event 11.3
Table 11.2-3 Risk Matrix 11.3

List of Figures

Figure 8.1-1 Land Use and Management Local Assessment Area and Regional Assessment Area 8.5
Figure 8.1-2 Land Use and Management Administrative Boundaries in the Local Assessment Area and Regional Assessment Area 8.7
Figure 8.1-3 Land Use and Management Land Ownership in the Local Assessment Area and Regional Assessment Area 8.12
Figure 8.1-4 Land Use and Management Lease Status in the Local Assessment Area 8.17
Figure 8.1-5 Land Use and Management Agriculture and Forestry Tenures in the Local Assessment Area and Regional Assessment Area 8.20
Figure 8.1-6 Surface Water Intakes in the Water Quality Regional Assessment Area 8.22
Figure 8.1-7 Land Use and Management Recreation Features in the Local Assessment Area and Regional Assessment Area 8.28
Figure 8.1-8 Land Use and Management Hunting and Trapping in the Local Assessment Area and Regional Assessment Area 8.31
Figure 8.1-9 Land Use and Management Infrastructure in the Local Assessment Area and Regional Assessment Area 8.35
Figure 8.2-1 Socio-economic Resources Regional Assessment Area 8.65
Figure 8.3-1 Public Health and Safety Local Assessment Area and Regional Assessment Area 8.111
Figure 8.3-2 McLean Creek Public Land Use Zone 8.114
Figure 8.3-3 Flood Hazard in Bragg Creek 8.122

8.0 HUMAN ENVIRONMENT

8.1 LAND USE AND MANAGEMENT

This section describes potential effects of to Land Use and Management from the proposed Elbow River at McLean Creek Dam (MC1) Option (MC1, Option, or MC1 Option). For the purposes of this assessment, the Land Use and Management Valued Component (VC) refers to the range of current human activities on the land base, and how these activities are managed to achieve land use outcomes.

The assessment in this section are supported by or linked to the assessments in the following sections:

- Section 6.1 Atmospheric Environment
- Section 6.3 Hydrogeology
- Section 6.5 Water Quality
- Section 7.1 Vegetation and Wetlands
- Section 7.2 Wildlife and Wildlife Habitat
- Section 7.3 Aquatic Environment

8.1.1 SCOPE OF ASSESSMENT

This section reviews the scope of the assessment for the Land Use and Management VC, and includes the regulatory framework, data sources, measurable parameters, and assessment boundaries relevant for Land Use and Management.

8.1.1.1 Regulatory Framework

The MC1 Option is located on the Elbow River in the Green Zone on Crown Land, approximately 10 kilometres (km) southwest of the town of Bragg Creek and in the Kananaskis Improvement District (KID). Regulations applicable to the Land Use and Management VC are summarized in **Table 8.1-1**.

Table 8.1-1 Summary of Applicable Regulatory and Policy Framework for Land Use and Management

Name	Jurisdiction	Description
Public Lands Act, RSA 2000, c. P-40	Provincial	Legislates activities on public land occur in a safe, sustainable, orderly and environmentally responsible manner. The Public Lands Administration Regulation (2017) identifies acceptable purposes and activities that may occur on public land. The Alberta Energy Regulator is responsible for energy-related activities and Alberta Environment and Parks (AEP) is responsible for non-energy related activities.
Land Stewardship Act, 2009, c. A-26.8	Provincial	Enacts regional land use planning which define regional outcomes (economic, environmental, and social), and establishes the legal basis for the development of regional plans. Provides regulations concerning the implementation of regional plans under the Alberta Land-use Framework (LUF). The South Saskatchewan Regional Plan was developed under the Alberta LUF, and applies to the Option.

Name	Jurisdiction	Description
Historical Resources Act, RSA 2000, c. H-9	Provincial	Applies to all developments in Alberta on both public and private lands, except land under federal authority. Sections 31, 32, and 37(2) within the Act are important for developers: S.31 states that notification to the Minister is required if a historical resource is discovered during an excavation. S.32 establishes title to archaeological property as vested in the Crown, and S.37 provides the steps that must be taken if a historical resource is discovered.
Municipal Government Act, RSA 2000, c.M-26	Provincial	The KID was established pursuant to the Act in 1996. The KID works with, and provides input to, the Province of Alberta with respect to land use and resource management within the Improvement District.
Provincial Parks Act, RSA 2000, c. P-35	Provincial	Provincial Recreation Areas (PRA) are established under the Provincial Parks Act. PRAs are important to the management of adjacent Crown lands and waters, serving as staging areas to provide access to a range of outdoor recreation opportunities on adjacent lands and water bodies.

8.1.1.2 Data Sources

The scope of this assessment relies on information compiled from the review of publicly available sources as well as past and new studies for the Option. Data sources for the assessment of Land Use and Management included MC1-specific data, government databases, government planning documents and reports, and other publicly available literature. The data sources reviewed included:

- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009)
- Recommendations on the Elbow River major infrastructure decisions (AEP 2015)
- Review of two flood mitigation projects: Bragg Creek / Springbank off-stream flood storage and McLean Creek flood storage (Deltares 2015)
- Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: McLean Creek Flood Storage (IBI Group 2015)
- Cougar Creek Debris Flood Retention Structure Environmental Impact Assessment (Town of Canmore 2016)
- Environmental Impact Assessment – Glacier Power Ltd. Dunvegan Hydroelectric Project (Jacques Whitford 2006)
- Site C Clean Energy Project Environmental Impact Statement, Volume 3 (BC Hydro 2013)
- South Saskatchewan Regional Plan 2014-2024 (Government of Alberta 2017a)
- Greater Bragg Creek Area Structure Plan, Bylaw C-6260-2006 (Rocky View County 2007)
- Kananaskis Country Recreation Policy (Government of Alberta 1999)
- Kananaskis Country Sub-Regional Integrated Resource Plan (IRP) (Government of Alberta1986)
- Kananaskis Country Provincial Recreational Areas Management Plan (Government of Alberta 2012).

8.1.1.3 Valued Components

Land Use and Management may interact directly with the MC1 Option (e.g., current uses of land and resources; unique sites and special features; recreational use of lands and waterways; access to recreational and resource use areas; and land use policies and resource management initiatives) (**Table 8.1-2**).

Table 8.1-2 Valued Components for Land Use and Management

Valued Component	Interaction
Land Use and Management	The Land Use and Management VC was selected to assess potential interactions of MC1 with land use policies and resource management initiatives, ownership status of potentially affected lands, current uses of land and resources, unique sites and special features, recreational use of lands and waterways, and access to recreational and resource use areas. The Land Use and Management VC also considers Option interactions with infrastructure, including removal and/or relocation of roads, buildings, facilities, pipelines, wellsites, and powerlines.

8.1.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and trends, and evaluate potential MC1-related effects to each VC.

The measurable parameters selected for the Land Use and Management VC are shown in **Table 8.1-3**. Potential adverse MC1-related effects to the Land Use and Management VC arising from potential interactions are discussed in more detail in **Section 8.1.3.**

Table 8.1-3 Measurable Parameters for Land Use and Management

Selected VC	Potential MC1-related Effects	Measurable Parameter
Land Use and Management	Changes to protected areas	Affected area (ha)
	Changes to recreational use	Recreational areas affected (ha) Proximity to recreational features (e.g., campgrounds, picnic sites, recreation areas)
	Changes to resource and commercial use	Overlap with resource uses (ha or %), attribute data of land uses (e.g., forestry, grazing, oil and gas operations, sand and gravel quarries, trapping areas [ha/km^2]), surface water intakes Provincial and regional zoning, development planning and land policies
	Change in hunting and trapping activities	Wildlife Management Units (WMUs) Guide outfitter allocations
	Change in the quality of the recreational experience	Recreational areas affected (ha) Proximity to recreational features (e.g., campgrounds, picnic sites, recreation areas)
	Disruption of infrastructure	Infrastructure removal and relocation (e.g., residences and other buildings, roads, pipelines, transmission lines) Road volumes, average travel time

8.1.1.5 Assessment Boundaries

Assessment boundaries define the maximum limits of an effects assessment and encompass the areas and times within which the MC1 Option would likely interact with the Land Use and Management VC.

Spatial Boundaries

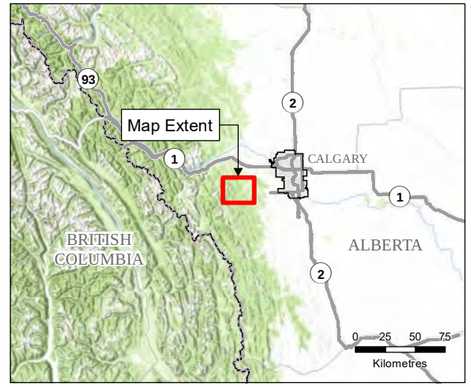
Spatial boundaries for the assessment of Land Use and Management are described in **Table 8.1-4**. The Local Assessment Area (LAA) encompasses the maximum geographical area where the Option is likely to interact with and potentially have a direct or indirect effect on Land Use and Management. The Regional Assessment Area (RAA), which encompasses the LAA, is established to provide a regional context for the assessment of MC1-related effects. The RAA also encompasses the area where the residual effects of the Option are likely to interact with the residual effects of other past, present, or future projects or activities to result in a cumulative effect or effects. The LAA and RAA for the Land Use and Management VC are shown in **Figure 8.1-1**

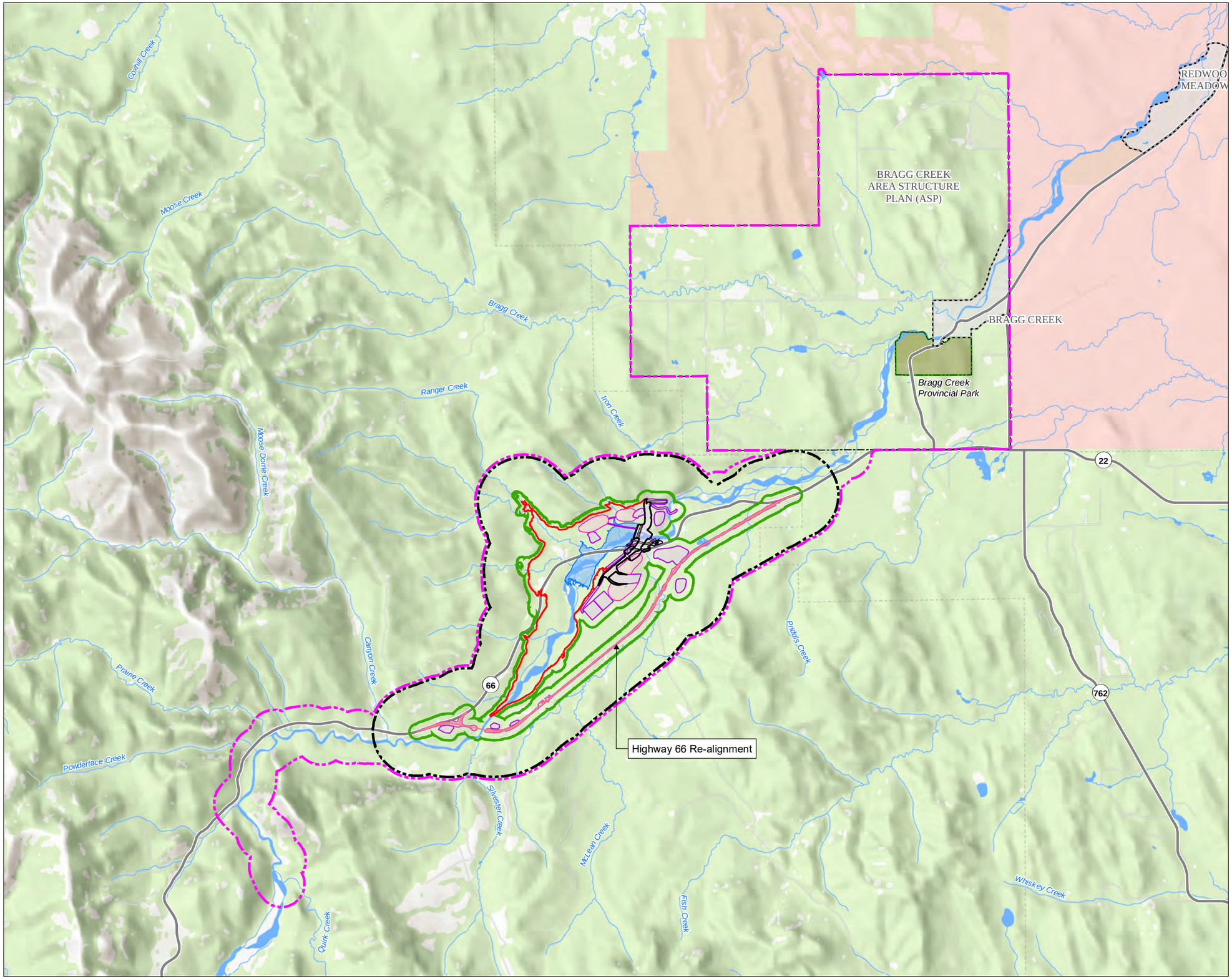
Table 8.1-4 Spatial Boundary Definitions for Land Use and Management

Spatial Boundary	Description of Assessment Area
MC1 Option area	The MC1 Option area comprises the MC1 footprint with a 100-m buffer applied to the embankment and excavation areas, spillways and outlets, and areas of road and utility relocation.
Local Assessment Area	The Land Use and Management LAA encompasses an approximately 1-km buffer around the MC1 Option area, the 2013 flood level, and the proposed realignment for Highway 66. The Land Use and Management LAA is the area with the highest potential for direct interactions with land and resource use and access to resource and recreational areas.
Regional Assessment Area	The Land Use and Management RAA is defined to capture the direct and indirect MC1-related effects and cumulative effects that may occur beyond the LAA. The RAA extends upstream approximately 9 km within the Elbow valley and adjacent slopes to the mouth of Quirk Creek, and downstream approximately 9 km to the Bragg Creek Area Structure Plan eastern boundary to include downstream land use.

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Local Assessment Area and Regional Assessment Area





Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Highway
- Reserve
- Bragg Creek Area Structure Plan Boundary
- Provincial Park
- Urban Area
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Temporal Boundaries

The temporal boundaries identified for the socio-economic assessment encompass periods during which the Option may affect the VC and include the Construction and Operation and Maintenance phases of the Option, which are described in **Section 3.0 Option Description**.

Administrative Boundaries

The Land Use and Management LAA and RAA overlap with the municipal boundaries of the KID, Rocky View County and the Municipal District of Foothills No. 31. The RAA is also contained in the land use plan area for the South Saskatchewan Regional Plan (SSRP). **Figure 8.1-2** shows the administrative boundaries pertaining to land use and management in the LAA and RAA. Land use plans and policies for municipal and regional planning areas are publicly available and have been reviewed to inform this assessment, and it is not anticipated that any administrative boundaries in the Land Use and Management RAA will affect the assessment of land use and management.

Technical Boundaries

Technical boundaries may be defined as the ability to accurately assess the potential effects of a proposed project on existing conditions. A desktop research approach was used to inform the potential effects of the Option on land use and management. Publicly available information on the extent and intensity of land uses may not be current or complete; therefore, field verification or consultation is typically used to verify desktop information. The scope of this assessment does not include field verification or consultation; however, the desktop approach is considered to be adequate to support the key findings of the land use and management assessment that highlight the importance of the RAA for recreational use.

Although it is acknowledged that the MC1 Option may interact with Indigenous groups interests with respect to land use and management, consultation and engagement with Indigenous groups would be required to understand relevant Indigenous groups' interests. No consultation or engagement was conducted in preparation of this assessment; thus, this assessment was based on desktop research only and Indigenous groups interests are not specifically included this assessment.

Entire map extent covered by the South Saskatchewan Regional Plan

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Administrative Boundaries in the Local Assessment Area and Regional Assessment Area

Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Reserve
- Bragg Creek Area Structure Plan Boundary
- Provincial Park
- Urban Area
- Watercourse
- Waterbody
- Green White Area Boundary
- Municipal Boundary

Public Land Use Zones

- McLean Creek Off-Highway Vehicle
- Sibbald Snow Vehicle
- The Kananaskis Country

SIBBALD SNOW VEHICLE

THE KANANASKIS COUNTRY

MCLEAN CREEK OFF-HIGHWAY VEHICLE

Highway 66 Re-alignment

GREEN AREA

WHITE AREA

KANANASKIS IMPROVEMENT DISTRICT

ROCKY VIEW COUNTY

BRAGG CREEK AREA STRUCTURE PLAN (ASP)

REDWOOD MEADOWS

BRAGG CREEK

Bragg Creek Provincial Park

ROCKY VIEW COUNTY

MUNICIPAL DISTRICT OF FOOTHILLS NO. 31

KANANASKIS IMPROVEMENT DISTRICT

MUNICIPAL DISTRICT OF FOOTHILLS NO. 31

Covhill Creek

Moose Creek

Bragg Creek

Ranger Creek

Moose Dome Creek

Iron Creek

Canyon Creek

Prairie Creek

Powderface Creek

Quirk Creek

Silvester Creek

McLean Creek

Fish Creek

Prichis Creek

Whiskey Creek

22

66

762

Notes

1. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map

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8.1.2 BASELINE CASE

The Construction and Operation and Maintenance phases of the MC1 Option are anticipated to result in the removal of existing recreational facilities and other physical infrastructure, the flooding of vegetation and wildlife habitat, and associated changes to existing land and resources.

Land use and land management interactions with the Option are likely to include:

- Land use policies and resource management initiatives;
- Current land and resource uses, including agriculture, forestry, recreation and tourism, hunting and fishing, trapping, oil and gas development, and sand and gravel quarries;
- Physical infrastructure such as roads, pipelines, well sites, and power lines; and
- Special features and unique sites.

The following sections provide a Baseline Case for Land Use and Management using data compiled from the sources listed in **Section 8.1.1.2**.

8.1.2.1 Land Use Policies and Resource Management Initiatives

The land area of the province of Alberta is divided for administration purposes into the White and Green Areas. The Green Area covers approximately 61% of the Province and is primarily forested Crown land, while the White Area is primarily urban and agricultural lands (Government of Alberta 2017a). The majority (95.0%) of the LAA is on Crown land in the provincial Green Area. The majority of the LAA is in Kananaskis Country, an area designated to encourage recreational use of lands while allowing for multiple resource uses. The park system in Kananaskis Country includes provincial parks, PRAs, wildland provincial parks, and an ecological reserve. Varying levels of protection apply to the different protected areas, and many unprotected areas throughout Kananaskis Country are used for recreation. Kananaskis Country is managed by the KID, an unincorporated municipal district that provides local government and municipal services to the residents of Kananaskis Country (KID 2015). The KID is responsible to the Minister of Alberta Environment and Parks (AEP), and has the mandate of managing the district for multiple uses, primarily timber harvesting, gas and oil extraction, cattle grazing, recreation and tourism (KID 2015).

The northeast edge of the LAA is in the Municipal District of Foothills No. 31 and overlaps with an area zoned for rural residential and agricultural use (Municipal District of Foothills No.31 2017) (**Table 8.1-5** and **Figure 8.1-2**).

Table 8.1-5 Administrative Boundaries in the MC1 Option area and Local Assessment Area

Administrative Area	MC1 Option area		LAA	
	Area of intersect (ha)	% of total area1	Area of intersect (ha)	% of total area1
Kananaskis Improvement District	1,044.8	100.0	3,634.0	94.8
Municipal District of Foothills No. 31	0.4	0.0	194.8	5.1
Rocky View County (Greater Bragg Creek area)	0.0	0.0	3.0	0.1

Sources: Alberta Environment and Sustainable Resource Development 2011a, AltaLIS 2017a
Note: 1 Due to rounding, percentages do not add up to exactly 100%.

Land use management direction in Kananaskis Country is provided at a strategic level in the SSRP pursuant to the *Alberta Land Stewardship Act*, SA 2009, c. A-26.8 (Government of Alberta 2017a). The South Saskatchewan Region includes the Cities of Calgary, Lethbridge, and Medicine Hat, and defines the most southerly portion of the province. This plan sets out an approach to manage land use in the region for the long term, and is an iterative plan designed to be reviewed every 10 years. Regional planning direction in the context of the provincial Land Use Framework (LUF) aims to manage the cumulative effects of development on the environment, by understanding the effects of multiple development pressures and improved integration of economic, environmental and social considerations (Government of Alberta 2017a). The SSRP provides direction to activities on Crown lands through existing legislation (e.g., the *Public Lands Act*, RSA 2000, c. P-40, the *Forests Act,* RSA 2000, c. F-22, provincial park legislation, and sub-regional plans). The SSRP identifies Kananaskis Country as an important recreational and tourism area with the potential to become a major tourist draw for Alberta (Government of Alberta 2017a). The SSRP incorporates land use objectives from earlier plans including *A Policy for Resource Management of the Eastern Slopes* (Government of Alberta 1984).

The Kananaskis Country Recreation Policy (Government of Alberta 1999) provides direction for recreation use of public lands. The policy sets out the approach to sustainable recreation management of Kananaskis Country within the context of integrated resource and environmental management, and lists planning requirements for the area, including forest, water, and protected area management plans. In addition, the policy describes guidelines and restrictions on development and ownership within Kananaskis Country. For example, no townsites or permanent communities are permitted in Kananaskis Country (Government of Alberta 1999).

The Kananaskis Country Sub-Regional Integrated Resource Plan (IRP) is an older plan that still provides direction for forestry and other resource activities in Kananaskis Country (Government of Alberta 1986). The IRP describes the allocation, use, and coordinated management of natural resources within Kananaskis (Government of Alberta 1986). This IRP is identified for review and incorporation, where

necessary, under the umbrella of the larger regional plan (SSRP). Until this time, however, this IRP will remain in effect (Government of Alberta 2017a).

The Kananaskis Country Provincial Recreational Areas Management Plan prioritizes the management of Provincial Recreation Areas (PRAs) in the Kananaskis area, and provides background information and management intent statements, objectives, and strategies for the area (Government of Alberta 2012). McLean Creek, Elbow River, Elbow River Boat Launch, and Gooseberry PRAs are in the LAA.

The Area Structure Plan for Greater Bragg Creek, Bylaw C-6260-2006 contains the bylaws that administer the Greater Bragg Creek area, which comprises the northeast portion of the RAA (**Figure 8.1-2**). The Greater Bragg Creek area is identified as a "wildland/community interface" (Rocky View County 2007, p.14). Approximately 65% of the Greater Bragg Creek Area outside of the Hamlet of Bragg Creek is intended for agricultural development, specifically low-density agriculture such as grazing lands (Rocky View County 2007). The risk of wildfire is a key concern noted in the plan, due to old-growth forests in the plan area that continue from adjacent forest reserve lands. Outside of the Hamlet of Bragg Creek, approximately 26% of the Greater Bragg Creek area is zoned as rural residential (Rocky View County 2007). The plan emphasizes the importance of managing future development to include recreation opportunities, improve watershed protection and conservation of natural areas, and allow for expansion of residential areas and agricultural activities.

8.1.2.2 Land Ownership

This section describes ownership of lands in the LAA. Information on land uses in the surrounding RAA is also provided. Land ownership in the MC1 Option area and the LAA is shown in **Table 8.1-6.** Land ownership in the LAA and RAA is shown on **Figure 8.1-3.**

Table 8.1-6 Land Ownership in the MC1 Option Area and Local Assessment Area

Land Ownership	MC1 Option area		LAA	
	Area of intersect (ha)	% of total area[1]	Area of intersect (ha)	% of total area[1]
Municipal	0.0	0.0	0.0	0.0
Private	0.0	0.0	93.2	2.4
Provincial	964.8	92.3	3,522.9	91.9

Source: Alberta Data Partnerships Ltd. 2017

Notes: [1]Remaining percentage of area is of unknown ownership, including road rights-of-way

The MC1 Option is located on Crown land, including public lands that are identified for general recreation. The LAA intersects with a small area of municipal lands (< 0.01 ha) in the Greater Bragg Creek area of Rocky View County, and 93.2 ha of private lands in the northeast edge of the LAA, in the Municipal District of Foothills No. 31. No federal lands are identified in the LAA or RAA.

The downstream portion of the RAA, which is the Greater Bragg Creek area, primarily consists of private land. Residential areas include the Hamlet of Bragg Creek as well as subdivisions and rural residential areas outside the Hamlet. The nearest residential area to the Option is located approximately 2.1 km to the northeast, in the RAA. The Hamlet of Bragg Creek is on both sides of the Elbow River approximately 10 km downstream of the LAA. Crown lands in the Greater Bragg Creek area are primarily Grazing Leases. The RAA upstream of the LAA consists of Crown land.

The Tsuu T'ina Nation Indian Reserve No. 145 is located approximately 15 km downstream of the Option, east of the RAA (**Figure 8.1-1**). The Reserve is 294.17 square kilometres (km^2) in area (INAC 2017). Redwood Meadows is a non-First Nations community situated around a golf course on Tsuut'ina Nation lands, along the south banks of the Elbow River.

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Land Ownership in the Local Assessment Area and Regional Assessment Area

Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Reserve
- Bragg Creek Area Structure Plan Boundary
- Provincial Park
- Urban Area
- Watercourse
- Waterbody
- Municipal Boundary

Land Ownership

- Municipal
- Private
- Provincial

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map

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8.1.2.3 Lease Identification and Status

Dispositions

Dispositions are permits, licences, or leases that grant permission for a specific activity or development on a specific area of land, and are subject to fees, rules and standards (Government of Alberta 2014). Existing dispositions that overlap with the LAA are described below and listed in **Table 8.1-7**. Dispositions by purpose are shown in **Figure 8.1-4**.

- A Recreation Lease (REC2811) overlaps by 1.0% with the MC1 Option area, and is adjacent to Highway 66. The lease is owned by Easter Seals Alberta Society, and is the location of Camp Horizon, which offers residential camps for children and adults with disabilities and medical conditions, as well as Outdoor Education Projects for schools and other organizations (Easter Seals Alberta 2017).
- Two Mineral Surface Leases (i.e., oil and gas exploration) overlap with the MC1 Option area: MSL781267 is a well site with an access road, located on the north side of the Elbow River and inside the reservoir boundary for the Option (i.e., the MC1 Option area overlaps with 97.0% of MSL781267). A sump site (MSL130225) and associated roadway Licence of Occupation (LOC130222) are southwest of the Option on the edge of the reservoir and adjacent to Highway 66. The leases are both owned by Shell Canada.
- Three Grazing Leases are located in the LAA east of the MC1 Option area on both sides of the Elbow River. The LAA intersects with a small portion of two of the leases, and includes 97.5% of GRL33163. The edge of GRL33163 (0.05 ha) intersects with the MC1 Option area.
- A Miscellaneous Lease (DML920078) identified for commercial development is located north of Highway 66. The area is used for film set production (KID 2017). The MC1 Option area intersects with 33.9% of DML920078.
- Several easements for powerlines overlap the MC1 Option area and LAA. A total of three easements (EZE100002, EZE140080, and EZE890421) have 100% overlap with the MC1 Option area, and six easements for powerlines have 100% overlap with the LAA (**Table 8.1-7**). All powerline easements in the LAA are owned by Fortis Alberta Inc. Licences of Occupation for roadways and access roads cross the MC1 Option area and LAA, and provide access to tenured resource uses such as pipeline and well site access. One Licence of Occupation for a pipeline access road overlaps with the MC1 Option area (LOC001390).
- Pipeline Agreements and Pipeline Installation Leases overlap with the MC1 Option area and LAA. Approximately 14.9% of one pipeline overlaps with the MC1 Option area (PLA5098, owned by Atco Gas and Pipelines Ltd.)

Two Parks Easements (PEZ100001 and PEZ140001) are located entirely in the MC1 Option area. These dispositions are owned by Fortis Alberta Inc. and denote pipeline easements through Elbow River and McLean Creek PRAs.

Table 8.1-7 Existing Dispositions Overlapping with the MC1 Option area

Disposition ID	Disposition Type	Purpose	Status	Area (ha)	Area of Intersect (ha)	% of Intersect
REC2811	Recreation	Recreational Campsites	Active	24.8	0.3	1.0
MSL130225	Mineral Surface Lease	Sump Site	Letter of Authority	0.80	0.01	1.2
MSL781267	Mineral Surface Lease	Well Site and Access Road	Active	1.88	1.82	97.0
GRL33163	Grazing Lease	Grazing	Active	63.3	0.1	0.1
EZE100002	Easement	Powerline	Letter of Authority	0.3	0.3	100.0
EZE120385	Easement	Powerline	Letter of Authority	0.2	0.1	100.0
EZE140080	Easement	Powerline	Letter of Authority	3.4	3.4	100.0
EZE840116	Easement	Powerline	Letter of Authority for Amendment	16.8	5.2	30.9
EZE890421	Easement	Powerline	Active	0.5	0.5	100.0
DML920078	Miscellaneous	Commercial Development	Land Amendment Application	6.5	2.2	33.9
PLA5098	Pipeline Agreement	Pipeline	Active	1.49	0.2	14.9
RDS790062	Roadway	Roadway	Active	42.9	1.3	3.0
LOC001390	Licence of Occupation	Access Road	Letter of Authority	9.5	2.8	29.3
PEZ100001	TP&R Easement	Parks Easement	Active	0.40	0.40	100.0
PEZ140001	TP&R Easement	Parks Easement	Active	0.40	0.40	100.0

Source: AEP 2017a
Note: TP&R is a disposition type located in provincial parks.

Disposition Reservations and Notations

Disposition reservations or notations are not formal (i.e., authorized) dispositions, but are areas with a registered interest by one or more agency and where land use restrictions or a requirement for consultation are imposed with respect to surface disposition. Disposition reservations and notations in the LAA are described below and in **Table 8.1-8**. Reservations and notations are shown in **Figure 8.1-4.**

Crown reservations include Protective Notations (PNT) and Consultative Notations (CNT), which are registered by AEP and to which conditions to industrial activity apply. Crown reservations in the LAA include potential provincial parks, ungulate habitat protection area, grazing allotments, watercourse protection, and areas with topographic constraints or resource concerns:

- A PNT between Elbow River PRA and Elbow River Launch PRA (PNT140043) is identified as having provincial park potential. More than half of the PNT area (57.3%) overlaps with the MC1 Option area.
- Ungulate habitat protection areas (PNT860034) provide important winter range areas for ungulate species (refer to **Section 7.2 Wildlife and Wildlife Habitat** for further information). The MC1 Option area does not intersect with the PNT. The LAA intersects with 26.3% of PNT860034, which is located north of the Elbow River in the eastern portion of the LAA.
- PNT090086 is a 3,503.3 ha area that overlaps with 18.3% of the MC1 Option area and 55.2% of the LAA. The area is listed as containing multiple resource concerns, and was noted to contain areas of native grassland, specifically foothills fescue grassland.
- Within the LAA there are two grazing allotment areas identified as PNTs. Both allotments are held by Alberta Agriculture and Forestry. The MC1 Option covers approximately 3.3% (284.8 ha) of PNT930439 and 17.0% (253.7 ha) of PNT970058. Both notation areas are adjacent to or overlapping with the reservoir.
- A PNT for watercourse protection (PNT840065) is at the eastern boundary of the LAA, reserving an area north of the Elbow River, and an area with identified topographic constraints such as steep, rolling topography lies to the south (PNT780209).
- Consultative Notations in the LAA include a residential buffer area and a range improvement plan area. The residential buffer area (CNT140022) overlaps with the MC1 Option area (27.1%) north of the Elbow River PRA. The range improvement plan area is encompassed by Grazing Lease GRL36274.
- Disposition Reservations (DRS), including a firefighting base camp (DRS392 and DRS 150004) and a surrounding area identified for structural development (DRS12006). The firefighting base camp and the Elbow District Ranger Station are both located in this area north of Highway 66, including multiple buildings and other structures. The majority of DRS392 would be encompassed by the reservoir, and a portion of this disposition overlaps with the permanent pond. A description of identified existing structures in the LAA is in **Section 8.1.2.6**.
- Other DRSs include a waste disposal and reclamation site adjacent to Highway 66 in the eastern portion of the LAA (DRS800082), a sand and gravel removal area at the southern extent of the reservoir (DRS810028), and a holding reservation (HRS) south of Gooseberry PRA (HRS940044).
- Disposition Reservations for registered roadways (RRD) include Highway 66 and other roadways in the LAA (Government of Alberta 2014).

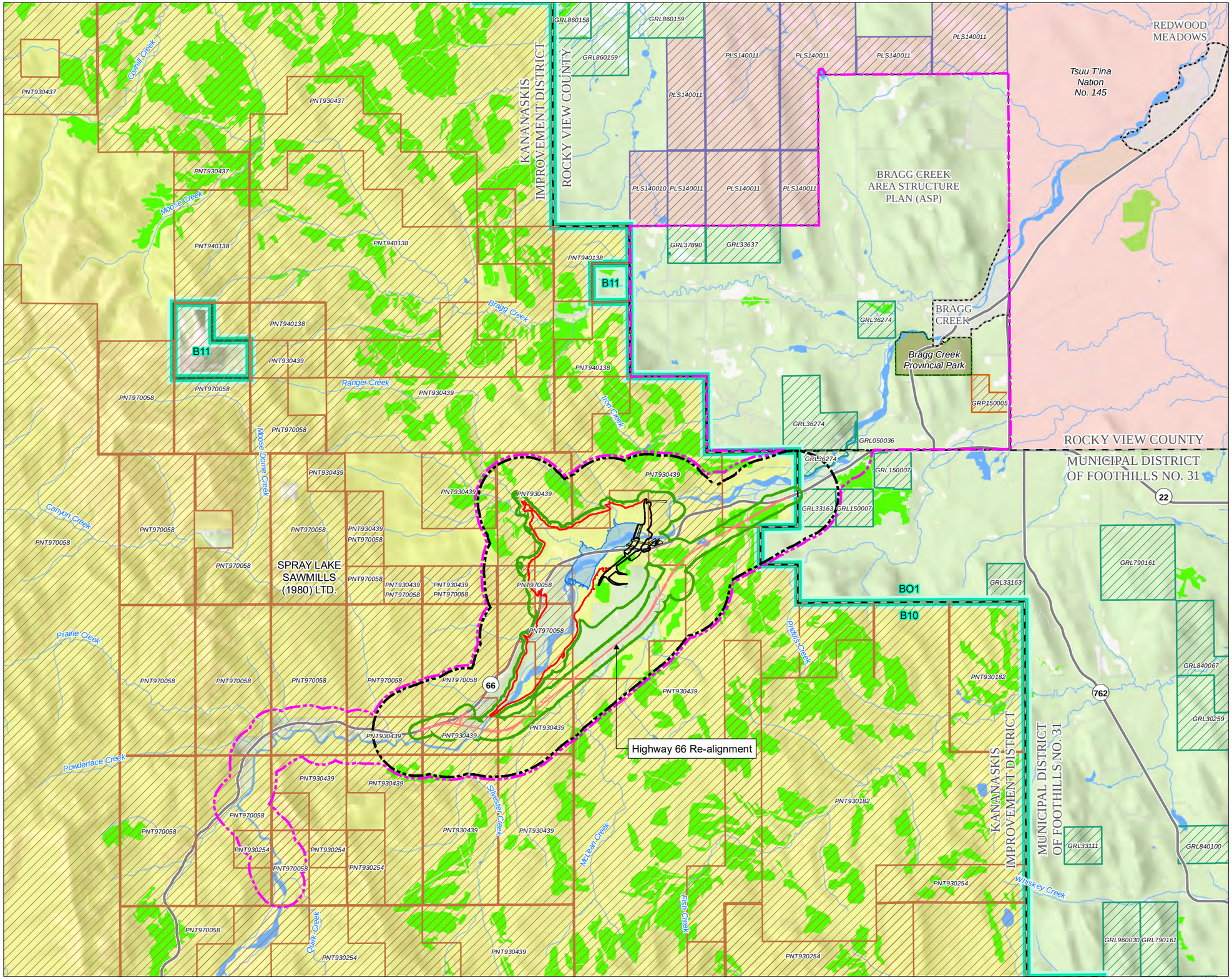
Table 8.1-8 Disposition Reservations and Notations Overlapping with the MC1 Option area

Reservation ID	Reservation Type	Purpose	Status	Area (ha)	Area of Intersect (ha)	% of Intersect
PNT090086	PNT	Multiple Resource Concerns	Active	3,503.3	640.1	18.3
PNT140043	PNT	Provincial Park Potential	Active	208.3	119.3	57.3
PNT930439	PNT	Grazing Allotment Area	Active	8,591.6	284.8	3.3
PNT970058	PNT	Grazing Allotment Area	Active	1,490.8	253.7	17.0
CNT140022	CNT	Residential Buffer	Active	587.7	159.3	27.1
DRS120006	DRS	Structural Development	Application	59.5	53.3	89.6
DRS150004	DRS	Firefighting Base Camp	Application	595.4	85.2	14.3
DRS392	DRS	Firefighting Base Camp	Active	35.3	35.3	99.9
DRS810028	DRS	Sand and Gravel Removal	Active	27.3	7.9	28.7
HRS940044	HRS	Transfer/Exchange Pending	Land Amendment Application	82.1	27.8	33.9
RRD8810268	RRD	Registered Roadway	Active	33.3	18.7	56.2
RRD8810269	RRD	Registered Roadway	Active	47.4	16.9	35.7

Source: AEP 2017a

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Lease Status in the Local Assessment Area and Regional Assessment Area



Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Bragg Creek Area Structure Plan Boundary
- Provincial Park
- Urban Area
- Watercourse
- Waterbody
- Municipal Boundary
- Existing Cut Block (as of 2014)
- Forest Management Area (FMA)
- Forest Management Unit (FMU)

Agriculture Disposition Types

- Grazing Lease (GRL)
- Grazing Permit (GRP)
- Private Land Sale (PLS)
- Protective Notation (PNT) - Grazing Allotment Area

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta, 2017
- Preferred Road Option and Disturbed Areas: Opus International Consultants Limited, 2017
- Dam Details: Hatch Ltd., 2017
- Cut Block: Alberta Biodiversity Monitoring Institute (ABMI) Human Disturbance dataset, 2014.
- Aerial Imagery: SPOT 1.5 m, 2016

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8.1.2.4 Current Land and Resource Uses

Current land and resource uses in the LAA include forestry, agriculture (i.e., cattle grazing), recreation, hunting and fishing, trapping, oil and gas development activities, and sand and gravel quarrying.

Forestry

The MC1 Option overlaps with Crown lands of the Rocky Mountain Forest Reserve, which is an extensive area of approximately 2.3 million ha over much of Kananaskis Country. Forest reserve lands are managed for watershed protection and accommodation of recreation uses, while allowing for forestry activities, cattle grazing, and oil and gas exploration (Government of Alberta 2012). The MC1 Option area (1,044.8 ha) lies entirely within the Rocky Mountain Forest Reserve, while 97.0% of the LAA overlaps with forest reserve lands. Forest management in Alberta is governed through the *Forests Act,* which allocates the right to harvest Crown timber to companies and individuals through forest tenures, including Forest Management Agreements (FMAs) (Government of Alberta 2016a).

Spray Lakes FMA encompasses the majority of the LAA, and is held by Spray Lake Sawmills (1980) Ltd, (Spray Lake Sawmills 2017). An FMA is awarded over a renewable 20-year term and requires long-term planning of the forest, including public consultation requirements (Spray Lake Sawmills 2017). The total area of the FMA is 284,745.5 ha, and includes a timber harvesting base of 223,152 ha. The MC1 Option area intersects with 765.9 ha, which is approximately 0.3% of the total area of the FMA.

The LAA is located within two Forest Management Units (FMUs): FMU B11, which is government managed, and FMU B10, which is held by Spray Lake Sawmills (1980) Ltd. (Alberta Agriculture and Forestry 2016). The total Annual Allowable Cut (AAC) in the South Saskatchewan Region in 2013/2014 was 582,373 m^3, representing 1.9% of the total AAC in Alberta in 2013/14 (Government of Alberta 2016b). Forest Management Unit B10, which comprises most of the land in the LAA, had an AAC of 144,944 cubic metres (m^3), or approximately 0.5% of the total AAC for the province in 2013/2014 (Government of Alberta 2016b). The total timber volume harvested compared to the AAC in Alberta's Green Area is declining; as a five-year rolling average, harvest volumes range from 84.0% in 2003 to 2007 to 66.4% from 2009 to 2013 (Government of Alberta 2016b).

In 2014, existing cut blocks were located throughout the LAA, with large cut blocks southeast of the MC1 Option area and north of the reservoir. The FMAs, FMUs, and existing cut blocks (as of 2014) are shown in **Figure 8.1-5**.

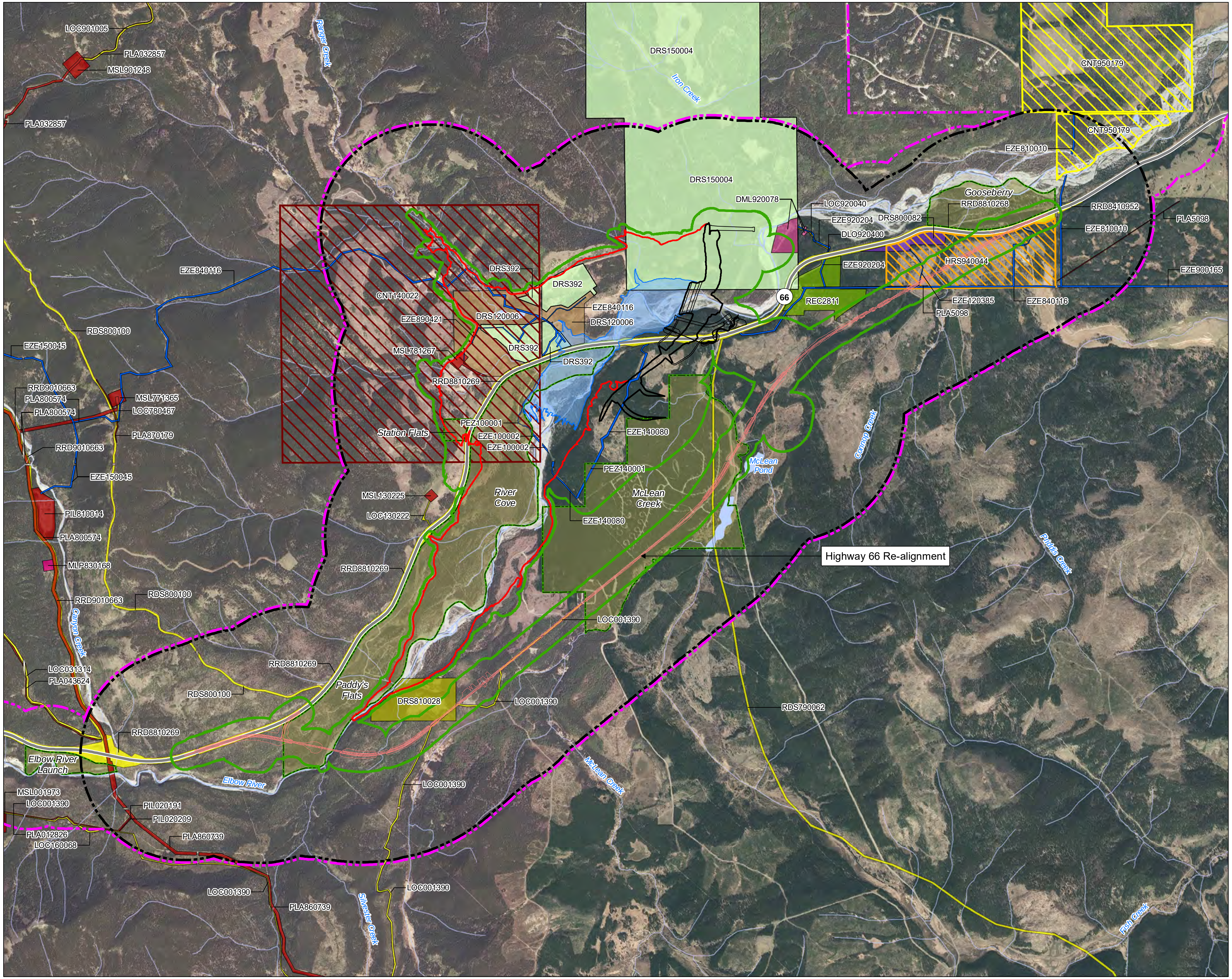
Agriculture

Agriculture in Alberta is a key component of the provincial economy, with farm cash receipts in 2015 totalling $13.6 billion, with $5.2 billion attributed to cattle production (Alberta Economic Development and Trade 2017). Through the SSRP, Alberta Agriculture and Forestry monitors the conversion of fragmentation of agricultural land as identified within the Alberta LUF (Government of Alberta 2017a).

Agricultural activities occur in the Elbow River watershed, but are reported to be low intensity (Elbow River Watershed Partnership 2009). Two grazing allotments cover approximately 51.5% of the MC1 Option area (**Figure 8.1-5**). Grazing allotments are protective notations on Crown lands regulated by the *Forest Reserves Act*, RSA 2000, c. F-20. Managers of grazing allotments must follow a rotational grazing system, and the allotments are typically only active from June to October (Elbow River Watershed Partnership 2009).

Three Grazing Leases are in the eastern portion of the LAA (**Figure 8.1-5**). Grazing Leases are formal dispositions designed to allow for cattle producers to use the forage resource on Crown land. Although Grazing Leases designate an exclusive right to use of the land for grazing, grazing allotments and leases allow public access under the Recreational Access Regulation (228/2003) pursuant to the *Public Lands Act,* where reasonable. Generally, public access is restricted to foot access (Alberta Grazing Leaseholders Association 2017).

In the RAA, Rocky View County's Agriculture Master Plan informs future planning decisions and policy development related to the support, development, and diversification of the regional agriculture industry (Rocky View County 2011). Agriculture is the most dominant land use within Rocky View County, accounting for 43% of the overall number of parcels and 92% of the overall land area in 2009 (Rocky View County 2007). In developed areas of the RAA, however, such as the Hamlet of Bragg Creek, agricultural activity is limited, partly due to conflicting land use priorities. Grazing operations have been noted as declining in the White Area in the Elbow River valley, due to land speculation purchases (Elbow River Watershed Partnership 2009). In many instances, agricultural activity within Hamlet areas is described as a transitional land use, practiced only in fringe areas (Rocky View County 2007).



Elbow River at McLean Creek Dam (MC1)

Land Use and Management Agriculture and Forestry Tenures in the Local Assessment Area and Regional Assessment Area

Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Provincial Recreational Area
- Watercourse
- Waterbody

Dispositions by Purpose

- Access Road or Roadway
- Oil and Gas
  (Includes cathodic potection/adode beds, compressor sites, pipelines, pipelines and installation, sump sites, valve sites and access roads, well sites and access roads)
- Commercial Development
- Firefighting Base Camp
- Other Industrial
- Powerline
- Range Improvement Plan
- Recreational Campsite
- Residential Buffer
- Sand and Gravel Removal
- Structural Development
- Transfer/Exchange Pending
- Waste Disposal/Reclamation Site

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dispositions: Government of Alberta, 2017
- Dam and flood details: Opus International Consultants Limited, 2017
- Aerial Imagery: SPOT 1.5 m, 2016

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Surface Water Intakes

Water is drawn from the Elbow River for multiple purposes including drinking water, irrigation of agricultural land and golf courses, stock watering, fish and wildlife management, habitat enhancement and recreation (Elbow River Watershed Partnership 2009). AEP issues water licences for surface water diversions under the *Water Act*. Surface water diversions for drinking water and other purposes are located downstream from MC1, to the Glenmore Reservoir. Locations of surface water intakes in the Water Quality RAA, and in the smaller Land Use and Management RAA are shown in **Figure 8.1-6**. A total of 62 surface water intakes are drawn from the Elbow River mainstem in the Water Quality RAA, upstream of the Glenmore Reservoir. The Water Quality RAA is defined by the Elbow River watershed, excluding the City of Calgary. Approximately half (30) of the intakes are identified as municipal (i.e., drinking water), 10 intakes are used for recreation purposes, 9 are for agricultural use, dewatering or irrigation, and the remainder are for other uses (Alberta Environment and Sustainable Resource Development 2011b). The majority of the intakes are downstream of the Option. Approximately eight upstream intakes are identified for recreational use, dewatering and fish management (Alberta Environment and Sustainable Resource Development 2011b).

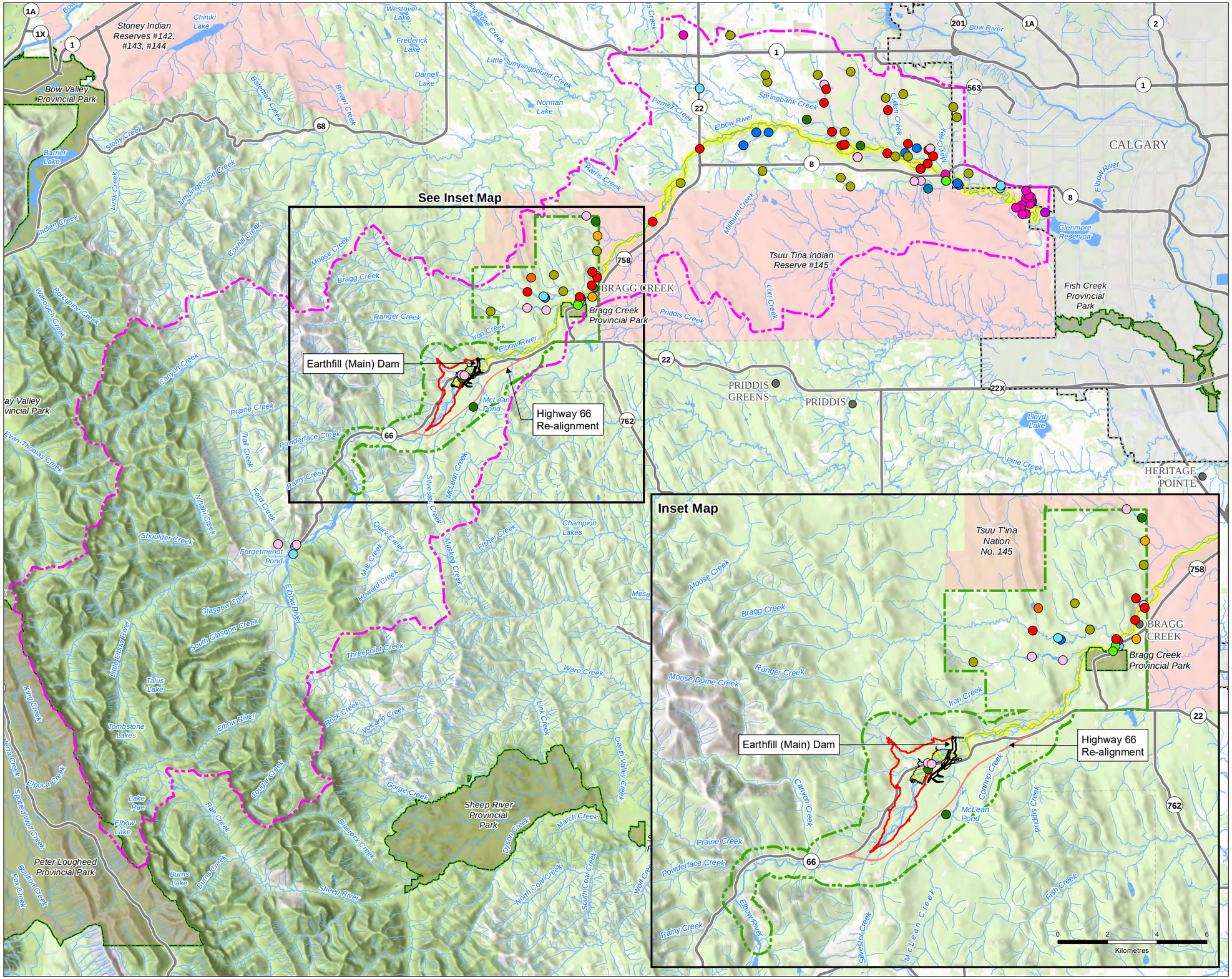
The Elbow River watershed is experiencing development pressure for increased subdivisions, golf courses and other development, and increasing recreational use (Elbow River Watershed Partnership 2009). Since August 2006, the South Saskatchewan River Basin has been closed to new water licence applications except for First Nations, Water Conservation Objectives, and water storage projects (as per an Approved Water Management Plan) (Alberta WaterPortal 2013).

Groundwater Wells

Information on groundwater wells affected by the Option is provided in **Section 6.3 Hydrogeology**.

Elbow River at McLean Creek Dam (MC1)

Surface Water Intakes in the Surface Water Quality Regional Assessment Area



Legend

- Surface Water Local Assessment Area
- Surface Water Regional Assessment Area
- Land Use and Management and Infrastructure Regional Assessment Area
- 2013 Flood Event (1,424.5 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Hamlet
- Highway
- Reserve
- Provincial Park
- Urban Area
- Watercourse
- Waterbody

Surface Water Diversion Locations

Purpose

- Agricultural
- Commercial
- Construction & Transportation
- Dewatering
- Government Hold Back
- Habitat Enhancement
- Industrial
- Irrigation
- Management of Fish
- Municipal
- Recreation
- Water Management

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta
- Diversion Locations: Alberta Environment, 2017
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Recreation and Tourism

Kananaskis Country recorded over 3.5 million visitors from 2003 to 2004 (Government of Alberta 2012). The MC1 Option is in the Elbow River Valley, which is considered one of the most heavily used single access points to Kananaskis Country. The high levels of recreational use are supported by proximity to Calgary and its accessible roads, facilities, and trail systems (Government of Alberta 2012). The most popular recreational activities in the area include hiking, picnicking, camping, mountain biking, horseback riding, off-highway vehicle (OHV) use, skiing, snowshoeing, target shooting, fishing and wildlife viewing. Paddling and rafting occur seasonally on the Elbow River. Hunting is not permitted in PRAs for safety reasons, but does occur on nearby forest reserve lands (Government of Alberta 2012). Hunting and fishing activities are described in more detail in following subsections.

The majority of the LAA north of the Elbow River is in the Kananaskis Country Public Land Use Zone (PLUZ), while the majority of the LAA south of the Elbow River is in the McLean Creek OHV PLUZ. Alberta's PLUZs are areas of public land where the Public Lands Administration Regulation (187/2011) applies conditions to protect sensitive resources and manage user activities. The Kananaskis Country PLUZ allows non-motorized recreational uses only, and has a total area of 112,923.0 ha, of which 509.3 ha (less than 1% of the total area of the PLUZ) is in the MC1 Option area. McLean Creek OHV PLUZ permits the use of OHVs (Government of Alberta 2017b). The MC1 Option area overlaps with 484.6 ha (2.4%) of the Mclean Creek OHV PLUZ, which was created to provide separate areas for motorized and non-motorized recreation. **Figure 8.1-7** shows PLUZs, PRAs, and areas and types of recreational uses in the LAA.

An extensive network of trails throughout the valley on the north side of the Elbow River are used year-round for mountain biking, skiing, snowshoeing, hiking, and horse riding (Greater Bragg Creek Trails Association 2017). Non-motorized recreational trails identified in the LAA are listed in **Table 8.1-9**. The non-motorized trail network is shown in **Figure 8.1-7**.

OHV trails are located throughout the McLean Creek OHV PLUZ, and the main access point is from McLean Creek PRA (**Figure 8.1-7**). Access from the PRA to OHV trails is closed from December 1 to April 30. Trails in the PLUZ are categorized for use by trucks, quads, and motorcycles. The area is described as one of the most popular places in Southern Alberta for OHVs (Bragg Creek & Kananaskis Outdoor Recreation 2014).

Table 8.1-9 Identified Non-motorized Recreational Trails in the Local Assessment Area

Trail Name	Approximate Access Location	Identified Trail Uses	Approximate Length (km)	Notes
Snagmore	Sugar Daddy and Elbow Trails	Mountain biking Snowshoeing	4.8	Partially in MC1 Option area, overlaps with dam
Elbow Trail	Highway 66 at Elbow Valley Ranger Station	Hiking Cross country skiing	6.9	Partially in MC1 Option area and reservoir
Sugar Mama	East of Elbow Valley Ranger Station on trail network	Mountain biking Snowshoeing	3.4	Partially in MC1 Option area, overlaps with dam
Sugar Daddy	East of Elbow Valley Ranger Station on trail network	Mountain biking Snowshoeing	3.8	Partially in MC1 Option area, overlaps with dam
Tom Snow	Station Flats Trailhead off Hwy 66	Mountain biking	28.1	Partially in MC1 Option area. Damaged in 2013 flood, poorly maintained
Ridgeback 2	Sugar Mama, other trails in trail network	Mountain biking	2.3	Partially in MC1 Option area
Bobcat	Ridgeback, other trails in trail network	Mountain biking Hiking	4.0	Partially in MC1 Option area
Diamond T Loop	Elbow Valley and Tom Snow Trails	Horse riding Hiking	3.9	Partially in MC1 Option area.
Elbow Valley	Station Flats Trailhead off Hwy 66, Ing's Mine Road, Moose Mountain Road	Mountain biking Hiking Horse riding	9.0	Connector trail Partially in MC1 Option area and reservoir
Sulphur Springs	Stations Flats trailhead at Elbow Valley Trail	Mountain biking Hiking Horse riding	5.8	Connector trail
Pneuma	Moose Mountain Road off Hwy 66 and other trai,ls	Mountain biking	10.3	-
Special K	Pneuma Trail or Moose Mountain Road	Mountain biking	4.8	-

Sources: Braggcreek.ca, Pinkbike 2017

Water-based recreational activities that occur in the LAA include canoeing, kayaking, paddle boarding, jet-boating, and commercial rafting. Kayakers put in at Elbow Falls and take out at Elbow River Boat Launch PRA. This section of river is fast and shallow with Class III and Class IV rapids, and is used by experienced whitewater paddlers only (Paddling ABC 2016). Several commercial outfitters offer guided whitewater rafting and kayaking trips on the Elbow River in May and June, when water levels are high enough (Bragg Creek & Kananaskis Outdoor Recreation Ltd. 2014). Further downstream, the Elbow River is described as a slow-moving, shallow river that is popular with bathers, tubers and families (Bragg Creek & Kananaskis Outdoor Recreation Ltd. 2014).

Provincial Recreation Areas are established to provide access and staging areas for recreational uses while protecting significant natural, cultural, and scenic values within and adjacent to these areas (Government of Alberta 2012). A total of four PRAs are located in the LAA: McLean Creek, Elbow River, Elbow River Boat Launch, and Gooseberry PRAs. **Table 8.1-10** describes the degree of overlap of the PRAs with the MC1 Option area and LAA.

Table 8.1-10 Provincial Recreation Areas in the Local Assessment Area

PRA	Total Area (ha)	Area (ha) within MC1 Option area	% of intersect in MC1 Option area	Area (ha) within LAA	% of intersect in LAA
Elbow River	236.2	171.1	72.4	236.2	100.0
McLean Creek	245.1	101.7	41.5	245.1	100.0
Gooseberry	41.4	5.3	12.8	41.4	100.0
Elbow River Boat Launch	11.9	0.0	0.0	3.7	31.4

Source: AEP 2017d

The SSRP, the Bragg Creek Provincial Park Management Plan, and the Kananaskis Country Provincial Recreational Areas Management Plan all outline the future consolidation of the Elbow River Valley PRAs with Bragg Creek Provincial Park into what will be renamed Elbow Valley Provincial Park. McLean Creek PRA will remain a separate PRA to continue to accommodate OHV use in the McLean Creek PLUZ (Government of Alberta 2012).

Campground capacity in the Elbow River Valley is provided in **Table 8.1-11**. According to the most recent available Alberta park user statistics from 2003/2004, Kananaskis Country overall was visited by 3 million day users and approximately 400,000 campers in that year (Government of Alberta 2012). Elbow River Valley campgrounds in summer were reported to be either approaching or at high occupancy levels, reporting 81,000 campers and 360,000 day-use visitors in 2003-2004 (Government of Alberta 2012). Mountain bike use in the Elbow area is reported to be increasing noticeably from year to year. Traffic along Highway 66 was noted to have increased by 13% from 1993 to 2003 (Government of Alberta 2012).

Table 8.1-11 Campgrounds in the Local Assessment Area

Campground	Total # of Sites	Site Types	Season	Cost per site per night (Basic per serviced site)
McLean Creek	170	74 basic 96 serviced	Year round	$26/$33, $12 reservation fee from May – Oct
Paddy's Flat	98	98 basic	May-Sept	$26
River Cove	15-20 (group sites)	15-20 group sites	Year round	$31, minimum booking 10 sites, $12 reservation fee
Gooseberry	85	28 basic 51 serviced 6 walk-in	Year round	$26 $33 $26
Total Sites	Approximately 373	-	-	-

Source: Government of Alberta 2017c, d, e, f

McLean Creek Provincial Recreation Area

McLean Creek PRA is located south of Highway 66, along a public access road. McLean Creek campground has 170 basic and serviced sites available year-round. Winter use includes winter picnicking, hiking and ice fishing (Government of Alberta 2012). Additional day use areas within the PRA include a staging area to access the extensive OHV trail network in the McLean OHV PLUZ; McLean Pond day use area, which is popular for fishing; an amphitheater, interpretive trail and mountain biking/hiking trails in the McLean Creek PRA (Government of Alberta 2017c). This PRA did not incur any damage from the 2013 floods. The MC1 Option area overlaps with 41.5% of the McLean Creek PRA. McLean Creek Camper's Centre is a store adjacent to the campground off McLean Creek Trail, offering camping supplies, firewood, showers, food and fuel.

Elbow River Provincial Recreation Area

The Elbow River PRA is located on the north and south side of Highway 66, and is entirely located within the LAA (**Table 8.1-10**). The MC1 Option area overlaps with 72.4% of the Elbow River PRA. The Elbow River PRA contains extensive facilities and trails, including Paddy's Flat campground, River Cove group campground, Station Flats and Allen Bill Pond day use areas, and a variety of trails used for hiking, mountain biking, trail running, and horseback riding (Government of Alberta 2017d). These facilities include:

- Campgrounds: Paddy's Flat Campground (100 campsites, open May to September) and River Cove Group Use Campground (15 to 20 campsites, year-round)
- Trail access to Paddy's Flat Interpretive Trail (2.2 km); Riverview Trail (2.7 km), Elbow River Trail, Fullerton Loop Trail (6.8 km). Many trails were damaged in the 2013 flood and have been restored.
- Station Flats, a hiking, mountain biking and horse riding trailhead located on the north side of Highway 66

- Allen Bill Pond, destroyed during the 2013 flood; some facilities still remain intact, including vault toilets and several reconstructed trailheads. Prior to the 2013 flood, Allen Bill Pond was stocked with rainbow trout and was a popular destination for fishing (Government of Alberta 2012).

Gooseberry Provincial Recreation Area

Gooseberry PRA is between Highway 66 and the Elbow River, downstream of Elbow River PRA. The Elbow Valley Visitor's Information Centre is in the PRA adjacent to the highway, and is open from May to October. Gooseberry Campground has 80 campsites (Government of Alberta 2017e). The MC1 Option area overlaps with 12.8% of the Gooseberry PRA.

Elbow River Boat Launch Provincial Recreational Area

The Elbow River Boat Launch PRA is located south of Highway 66, immediately upstream from the Elbow Falls PRA. Facilities include a boat launch area, fire pits, and pit toilets (Government of Alberta 2017f). The MC1 Option area does not directly overlap with the Elbow River Boat Launch PRA.

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Recreation Features in the Local Assessment Area and Regional Assessment Area

Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Road
- Trail or Unimproved Road
- Bragg Creek Area Structure Plan Boundary
- Urban Area
- Watercourse
- Waterbody
- Municipal Boundary
- Provincial Park
- Provincial Recreational Area
- Recreational Trail

Public Land Use Zones

- McLean Creek Off-Highway Vehicle
- Sibbald Snow Vehicle
- The Kananaskis Country

- Amphitheatre
- Boat Launch
- Camping
- Camping (Group)
- Camp Horizon
- Fishing
- Grocery/Supply Store
- Hiking (Backcountry)
- Information Kiosk
- Interpretive Hiking
- Lookout
- Pay Phone
- Picnic
- Sewage Disposal
- Staging Area

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Recreational Data: Alberta Parks, 2017
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map

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Hunting

Hunting in the LAA is administered through Wildlife Management Units (WMUs) under the responsibility of the Alberta Environment and Parks. The majority of the LAA is located within the Elbow WMU (WMU 406) (**Figure 8.1-8**). Hunting is not permitted in PRAs for public safety reasons, but does occur in forest reserve lands in the Elbow River Valley (Government of Alberta 2012). A small area of the Priddis WMU (312) overlaps with the eastern edge of the LAA and the Bragg Creek area of the RAA. The WMUs provide regulations for general (i.e., firearms, crossbow, and archery) and archery-only hunting seasons, by species. For example, most ungulate species may be hunted by bow only in mid-September in WMU 406, after which the general season opens for the remainder of the fall (Government of Alberta 2016c). General hunting regulations for selected game species in WMU 406 are provided in **Table 8.1-12**.

Guide outfitters operate within WMU 406, and hold a total of 61 allocations for the following species: black bear (4), elk (4), mule deer (30), moose (7), and white-tail deer (16). Guide outfitters operating in the area provide hunting trips for elk and mule deer for residents and non-residents (CCC Outfitters 2012).

Anecdotal (i.e., non-verified) information suggests that hunting in the LAA may be low intensity, due to the popularity of hiking, mountain biking, camping, and other recreational activities in the area (Jelsoft Enterprises 2017). Mule deer and white-tailed deer are reported to be plentiful in the area. Hunters must enter a special draw to hunt moose. Hunting likely also occurs in the private parcels in the LAA if landowners grant hunters access (Jelsoft Enterprises 2017).

Table 8.1-12 2016 General Hunting Regulations in Wildlife Management Unit 406

Species	Method	General Season
White-tailed deer Mule deer Moose	Archery	September 7 to 23
	General	September 24 – November 30
Elk (6-point antlers or larger, and antlerless)	Archery	September 7 to 16
	General	September 17 – November 30
Sheep (trophy) [1]	General	September 7 to October 31 (residents only)
Sheep (non-trophy)	General	September 10 to October 31 (special licence draw)
Black bear	General	April 1 to May 15; September 7 to November 30
Cougar	General	December 1 to February 28
Pheasant (male) Ptarmigan Ruffed grouse Spruce grouse Blue grouse	General	September 8 to January 15 (daily limits and possession limits apply)

Source: Government of Alberta 2016c
Note: [1]Trophy sheep are defined as mature male bighorn sheep.

Fishing

The LAA is in the Eastern Slopes Fish Management Zone 1. The Elbow River and tributaries in the LAA support populations of sportfish and non-sportfish species. Detailed information on species composition and abundance is provided in **Section 7.3 Aquatic Environment**. Sportfish species of management concern present in the Elbow River include bull trout (*Salvelinus confluentus*), brook trout (*Salvelinus. fontinalis*), rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), brown trout (*Salmo truttta)*, mountain whitefish (*Prosopium williamsoni*), northern pike *(Esox lucius*), and burbot *(Lota lota)* (AEP 2017b). Although there are no fish species currently listed under Schedule 1 of the *Species at Risk Act* (*SARA*) within the MC1 Option area, bull trout populations in the Elbow River are currently under consideration for inclusion under Schedule 1 (refer to **Section 7.3 Aquatic Environment)**. Fishing for trout is catch and release with the exception of brook trout **(Table 8.1-13**).

The Elbow River is a popular destination for recreational fishing. Catch-and-release fishing for trout and whitefish is permitted from Canyon Creek east. Daily limits by species and size restrictions apply in the Elbow River and tributaries (Government of Alberta 2017g). Fishing regulations specific to the Elbow River area in the LAA are shown in **Table 8.1-13**.

Table 8.1-13 2017 Fishing Regulations Applicable to the Local Assessment Area

Location	Timing	Restrictions
Elbow River headwaters to Elbow Falls, and tributaries except Quirk Creek	June 16 to October 31	Brook Trout Limit 2 Other trout limit 0 Bait ban
Elbow Falls to Canyon Creek	All year	Closed
Canyon Creek to Highway 22, river only	June 16 to October 31	Trout and whitefish limit 0 (catch and release only) Bait ban
	November 1 to June 15	Closed

Source: Government of Alberta 2017g

Since Allen Bill Pond was destroyed by the 2013 flood, McLean Pond in the McLean Creek PRA is one of only two fishing ponds in the area. Forget-me-not Pond is upstream of Elbow Falls (Bragg Creek n.d., Government of Alberta 2017d). Recreational fishing is open all year for McLean Pond, which is stocked with rainbow trout and is a popular fishing area for families (Bragg Creek & Kananaskis Outdoor Recreation 2014).

Trapping

Trapping in the LAA is administered within Registered Fur Management Areas (RFMAs). Currently, two RFMAs, (2562 and 298) intersect with the LAA, signifying that trapping may occur within the area (**Figure 8.1-8**). The current locations of trap lines for the identified RFMAs are unknown, as trap line information is proprietary and not made publicly available in Alberta. Direct consultation with trappers is required to obtain this information.

Entire map extent covered by the Eastern Slope Fish Management Zone

Highway 66 Re-alignment

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Hunting and Trapping in the Local Assessment Area and Regional Assessment Area

Legend

- MC1 Option Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Permanent Pond
- Highway
- Bragg Creek Area Structure Plan Boundary
- Provincial Park
- Urban Area
- Watercourse
- Waterbody
- Municipal Boundary
- Registered Fur Management Area Boundary
- Wildlife Management Unit Boundary

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map

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Oil and Gas Development

Oil and gas development activities in Alberta are regulated under the *Responsible Energy Development Act*, SA 2012, c. R-17.3 (Government of Alberta 2017a). One well site and one sump site are in the MC1 Option area, as discussed in **Section 8.1.2.4**.

Mineral and Aggregate Resources

The LAA does not contain any coal dispositions or mines, metallic mineral deposits of commercial interest, or mineral exploration activities. Coal extraction occurred in the past from a small coal deposit near Canyon Creek at the base of Moose Mountain, approximately 15 km west of MC1 (Government of Alberta 1986).

Aggregate resources, including sand and gravel, are used in road and facility construction. Aggregate extraction is regulated by the Public Lands Administration Regulation, pursuant to the *Public Lands Act* (Government of Alberta 2017h). A sand and gravel quarry is located south of the Elbow River opposite Paddy's Flat (DRS810028).

Land Use in the Regional Assessment Area

Upstream of the LAA, the RAA includes the Elbow River and a 1-km buffer on both sides. The upstream RAA includes the western portion of the Elbow River Boat Launch PRA, which is used by paddlers and rafters. Elbow Falls PRA is a highly popular location for day use year-round, even though a large portion of the day use area was destroyed in the 2013 flood. The falls, parking area, and viewpoints are still accessible. Highway 66 west of Elbow Falls is closed annually from December 1 to May 14.

A Mineral Surface Lease for oil and gas activities (MSL001973) is located south of the river in the RAA. Beaver Flats Campground is located in the RAA upstream of the falls, and includes 49 campsites and access to trails for non-motorized users. The area is also used as a launch site for experienced paddlers (Government of Alberta 2017i).

Downstream of the LAA, the RAA is defined by the Greater Bragg Creek Area Structure Plan, which includes the Hamlet of Bragg Creek with retail and business areas. Outside of the Hamlet are several residential areas as well as a golf course, Grazing Leases, and forested Crown land (Rocky View County 2007). The Area Structure Plan contains a mix of Crown lands, municipal lands, and private lands (**Figure 8.1-3)**. The Greater Bragg Creek Area Structure Plan is in Rocky View County.

Bragg Creek Provincial Park is a small park in the downstream RAA on the Elbow River, near the Hamlet of Bragg Creek. The park provides day uses including fishing, picnicking, and hiking. According to local descriptions, the trails that loop around the park show the extensive damage to the area from the 2013 floods (Hiking with Barry 2014). An extensive community trail network is planned for the Area Structure Plan to connect to trails in the provincial park and the Hamlet (Rocky View County 2007).

Land uses further downstream of the RAA include agricultural activities, rural residential areas and golf courses, and increasingly dense residential areas up to the Glenmore Reservoir, south of the City of Calgary.

8.1.2.5 Unique Sites and Special Features

The LAA and portions of the RAA are located within a Key Wildlife Biodiversity Zone (KWBZ), which includes a key winter ungulate habitat and an area of higher habitat potential for biodiversity. Industrial activity within the KWBZ is undertaken in consideration of maintaining areas of biodiversity and productive ungulate populations and applies strategies that:

a. Protect vegetation from being cleared by minimizing all industry activity
b. Minimize activity during winter months to avoid displacing wildlife
c. Reduce access or do not create new access
d. Follow general timing restrictions (Government of Alberta 2015a).

The RAA is also in Grizzly Bear Management Area (BMA) 5, or the Livingstone BMA, which sets out zoning for recovery, support, and habitat linkage areas for grizzly bear (refer to **Section 7.2 Wildlife and Wildlife Habitat** for further information on the KWBZ and BMA).

Environmentally Significant Areas are established to support and contribute to the long-term maintenance of biological diversity, soil, water, and other natural processes, and may contain rare or unique elements that require special management consideration. These are not protected areas, but are intended to inform land use planning and policy at local, regional, and provincial scales (Fiera 2014). Environmentally Sensitive Area 8, located within the Rocky Mountain Natural Region, overlaps the LAA (Fiera 2009). This Area contains 45 elements of conservation concern including birds, mammals, insects, and vegetation, as well as areas of hydrological importance, but is not recognized as containing important wildlife habitat (Fiera 2009). Environmentally Sensitive Area 8 has a total area of 94,799.2 ha, of which 1,926.7 ha or 2.0% intersects with the LAA. A total of 327.2 ha (0.4%) of Environmentally Sensitive Area 8 overlaps with the MC1 Option area. Approximately 0.1% of Environmentally Sensitive Area 12 also overlaps with the LAA.

Within the LAA there are four PRAs, as described in **Section 8.1.2.4**. No wetlands of international importance recognized under the Ramsar Convention are located in the LAA (refer to **Section 7.1 Vegetation and Wetlands** for further detail on wetlands). The LAA also does not overlap with historic rangelands, heritage rivers, federal or provincial parks, or other identified protected areas.

8.1.2.6 Physical Infrastructure

Existing infrastructure within the MC1 Option area includes the Elbow Valley Ranger Station (EVRS) complex and firefighting base camp, facilities at McLean Creek campground, and Camp Horizon. The EVRS is located on the north side of Highway 66 along both sides of Ranger Creek, and serves staff from Alberta Forestry Protection Services, Alberta Parks and Recreation, and Alberta Fish and Wildlife. The complex can house up to 150 people. The EVRS main complex has offices for Alberta Forestry Services, Alberta Parks and Recreation, and Alberta Fish and Wildlife. The firefighting, search and rescue and maintenance base is on the west side of the complex, which features eleven permanent residences and three residential camping trailers, as well as seven large bunkhouses and four overflow bunkhouses; an historical ranger building; a kitchen and dining hall; storage sheds for fuel and supplies; office buildings and trailers; a septic treatment building, and other structures. The east side of the complex includes housing for rangers and campsite wardens as well as support buildings for campsite operations. The east compound has seven houses, an office building, shop/garage and septic tank and pumphouse, and other buildings (**Figure 8.1-9**). The water and sewage treatment plants provide services for the EVRS and the Elbow River Valley campgrounds in the area.

Other physical infrastructure in the MC1 Option area includes the following, previously described in **Section 8.1.2.4** and **Section 8.1.2.5.**

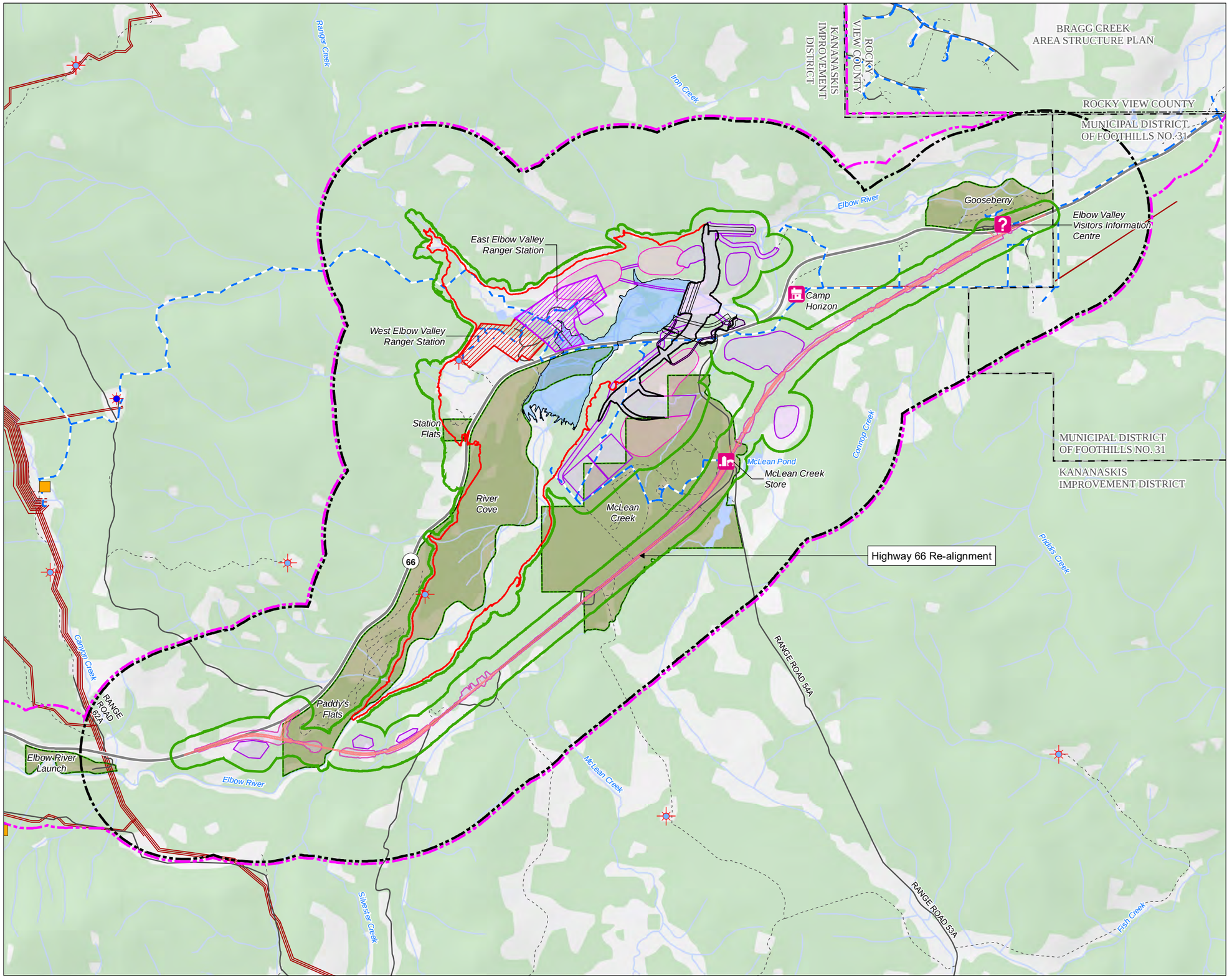
McLean Creek PRA: store, 170 campsites, playground, toilets, tap water and power.

- Elbow River PRA: Paddy's Flat (100 seasonal campsites), and day use area (parking area and trails) are partially in the MC1 Option area; River Cove Group Campground (15 to 20 campsites); Station Flats trailhead (parking area)
- Camp Horizon: Approximately 20 buildings and other structures, outdoor pool, trails, and a forest rope course owned and operated by Easter Seals Alberta Society.
- Gooseberry PRA: Elbow Valley Information Centre and 80 campsites are partially in the MC1 Option area.
- Highway 66
- Electrical transmission lines owned by Fortis Alberta
- Pipeline owned by Atco Gas and Pipelines Ltd.
- Access road owned by Husky Oil Corporation
- One well site and one sump area owned by Shell Canada Ltd.
- Non-motorized trail network on the north side of the Elbow River
- A commercial lease area north of Highway 66 contains approximately 20 buildings or other structures. In addition, two private land parcels in the eastern portion of the LAA both contain buildings.

Figure 8.1-9 provides an overview of infrastructure in the MC1 LAA and RAA.

Elbow River at McLean Creek Dam (MC1)

Land Use and Management Infrastructure in the Local Assessment Area and Regional Assessment Area



Legend

- Project Area
- Land Use and Management & Infrastructure LAA
- Land Use and Management & Infrastructure RAA
- 2013 Flood Event (1,424.1 m)
- MC1 Dam
- Highway 66 Re-alignment
- Borrow Area
- Laydown Area/Disturbed Area
- Permanent Pond
- Bragg Creek Area Structure Plan Boundary
- Municipal Boundary
- Provincial Recreational Area
- Watercourse
- Waterbody
- Camp Horizon
- Elbow Valley Visitors Information Centre
- McLean Creek Store
- Active Well Site
- Abandoned Well Site
- Oil and Gas Facility
- Oil or Gas Pipeline
- Fortis Electrical Transmission Line
- Highway
- Road
- Trail or Unimproved Road
- West Elbow Valley Ranger Station
- East Elbow Valley Ranger Station

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta & Government of Canada
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map

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8.1.3 APPLICATION CASE

The Application Case describes the potential MC1-related effects of the MC1 Option, which are added to the Baseline Case. The following sections present the potential MC1-related interactions and a description of potential effects and mitigation measures, along with an assessment of residual effects.

8.1.3.1 Potential Option Interactions

Physical works, including activities required for construction, as well as operation and maintenance of Option components may interact with the Land Use and Management VC. MC1-related interactions with the Land Use and Management VC include all Construction and Operation and Maintenance-phase activities that would take place in areas where other land or resource uses may occur (**Table 8.1-14**).

Table 8.1-14 Identification of Potential Option Interactions with Land Use and Management

Phase	Activity	Land Use and Management	
		Interaction	Potential Effect
Construction	Clearing	X	Changes to protected areas Changes to resource and commercial use Changes in recreational use Change in hunting and trapping activities Change in the quality of the recreational experience
	Road construction	X	
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	Disruption of infrastructure
	Dam (cofferdam and earth fill) construction	X	Changes to protected areas Changes to resource and commercial use Changes in recreational use Change in the quality of the recreational experience
	Spillway construction	X	
	Rock groin and diversion tunnels construction	X	
	Laydown areas construction and use	X	
	Stockpile development and use	X	
	Borrow and spoil areas development and use	X	
	Realignment of McLean Creek and other small waterbodies	X	Changes to protected areas Changes to resource and commercial use Changes in recreational use Change in the quality of the recreational experience

Phase	Activity	Land Use and Management	
		Interaction	Potential Effect
	Realignment of Highway 66	X	Changes to protected areas Changes to resource and commercial use Changes in recreational use Change in hunting and trapping activities Change in the quality of the recreational experience
	Storage of water in permanent pond	X	Changes to protected areas Changes to resource and commercial use Changes in recreational use Change in the quality of the recreational experience
	Reclamation	-	-
Operation and Maintenance	Routine and Flood Operations and Maintenance	X	Changes to resource and commercial use Changes in recreational use Change in the quality of the recreational experience

Note: X – potential interaction; '- '– no interaction

The Construction and Operation and Maintenance-phase activities listed above may interact with the Land Use and Management VC as follows:

- Changes to protected areas
- Changes to recreational use
- Changes to resource and commercial use
- Change in hunting and trapping activities
- Change in the quality of the recreational experience
- Disruption of infrastructure.

These potential effects of the Option are discussed in the following section.

8.1.3.2 Potential MC1-related Effects

This section includes consideration of potential adverse MC1-related effects on the Land Use and Management VC arising from potential interactions, as identified in **Table 8.1-14** and in relation to the measurable parameters listed in **Table 8.1-3**. Mitigation measures for each potential effect are described in **8.1.3.38.44.**

Changes to Protected Areas

The MC1 Option would directly affect recreation use areas and facilities in PRAs, which are protected for public recreation. Construction of the Option would directly affect portions of McLean Creek PRA, including the campground, McLean Creek store, and day use areas. A portion of the campground overlaps with the proposed work camp, contractor's offices, batch plant and borrow pits, and the store is in the right-of-way for the new highway realignment. McLean Pond day use area is adjacent to the MC1 Option area. Inundation of the permanent pond would affect River Cove Group Campground and Station Flat's day use area in Elbow River PRA. Gooseberry PRA overlaps with the MC1 Option area and access to the campground and interpretive centre would be affected during relocation of the highway, but no permanent loss of area is likely. The area of each PRA overlapping with the MC1 Option area is shown in **Table 8.1-15**.

Table 8.1-15 Provincial Recreation Areas in the MC1 Option area

PRA	Total Area (ha)	Area (ha) within MC1 Option area	% of intersect in MC1 Option area
Elbow River	236.2	171.1	72.4
McLean Creek	245.1	101.7	41.5
Gooseberry	41.4	5.3	12.8
TOTAL (ha)	522.7	278.1	-

Source: AEP 2017d

The changes to protected areas constitute a potential adverse effect. PRAs are established on public lands to provide access and staging areas for recreational uses and protect important natural, cultural, and scenic values (Government of Alberta 2012). The identification of alternative areas may help to offset the loss of these recreational use areas over the long term, should the Option go forward.

Changes to Resource and Commercial Uses

Construction activities including initial clearing; road construction; dam, embankment, and spillway construction; use of laydown and borrow areas and highway realignment would occur on lands which are identified for resource activities. Changes to resource and commercial land use would include lands used for grazing, forestry activities, oil and gas operations, commercial uses, and sand and gravel extraction. In addition to physical displacement of resource uses on lands affected by MC1, Construction-phase activities would affect access to areas of resource use in the LAA and RAA.

Two grazing allotments and a grazing lease intersect with the MC1 Option area (**Table 8.1-16**). Use of grazing allotments and grazing leases may be displaced by placement of the dam and service and axillary spillways. These activities may also be affected by relocation of Highway 66, stream and river relocation, and construction of the permanent pond. Portions of both grazing allotments are within the reservoir area. Grazing activities were noted in 2009 to be relatively low intensity in the Elbow River Valley area (Elbow

River Watershed Partnership 2009), although further information is required to verify the current extent of grazing activities.

The Option would require clearing of vegetation, and the dam and service and axillary spillways and access roads would be permanently removed from the forest land base. The total area of the FMA operated by Spray Lake Sawmills is 284,745.5 ha, and includes a timber harvesting base of 223,152 ha (Spray Lake Sawmills 2017). The MC1 Option area intersects with 765.9 ha, which is approximately 0.3% of the total area of the FMA (**Table 8.1**-**16**). In addition, the relocation of powerlines prior to construction would require further clearing of vegetation. The MC1 Option area overlaps with several cut blocks, and other cut blocks are in the dam and spillway location (**Figure 8.1-5**). Consultation with Spray Lake Sawmills (1980) Ltd. to determine the extent and nature of current and planned harvesting activities in the LAA is required to verify this potential effect.

Potentially affected resource and commercial use areas include a sand and gravel quarry, two oil and gas leases, and a miscellaneous lease used by the film industry, all listed in **Table 8.1-16**. Oil and gas activities currently appear to be inactive in the MC1 Option area and LAA, based on desktop research. Natural gas activities occur outside the LAA and RAA, particularly north of the LAA in the Moose Mountain area, to access resources in the Moose Mountain Gas Field. Husky Oil Corporation and Shell Canada operate a number of gas wells in the Moose Mountain area (Bragg Creek Environmental Coalition 2004). MC1 construction activities may affect access to these well sites, because access roads to the Moose Mountain area are accessed from Highway 66. A quarry site used for sand and gravel extraction (DRS810028) overlaps with the reservoir as well as the relocated alignment of Highway 66. Access to the Miscellaneous Lease (DML920078) would be temporarily affected by the relocation of Highway 66 farther to the south.

Potential Option interactions related to downstream water intakes are described in **Section 6.5 Water Quality**, including the potential for increased turbidity, introduction of chemical contaminants, methylmercury, septic waste, and organic matter combined with disinfectants to affect downstream water intakes. After mitigation, the release of nutrients leading to excessive algal growth and diminishing water quality downstream of the Option was identified as the only residual effect. Detailed information is supplied in **Section 6.5 Water Quality,** and potential effects on downstream water intakes are not further discussed in this section.

In summary, construction of MC1 would directly displace grazing lands, forest reserve lands and sand and gravel extraction activities. Access to the MC1 Option area and LAA for resource uses would also be affected. Access to resource use areas outside the LAA would be affected by road delays and temporary closures during highway relocation. The Option would not have a potential effect on oil and gas activities in the LAA, based on current information. During the Operation and Maintenance phase, it is likely that access to grazing lands and sand and gravel operations in the LAA would be restored, with the exception of areas permanently affected by dam components, infrastructure relocation and the highway realignment. Forestry

activities in the LAA may also resume, noting the modest reduction in the forest land base due to highway, watercourse and infrastructure relocation, and the presence of dam components.

Table 8.1-16 Summary of Potential MC1-related Effects to Resource and Commercial Use Areas

Description	ID Number	Total Area (ha)	Area (ha) within MC1 Option area	% of intersect in MC1 Option area
Grazing Allotment	PNT930439	8,591.6	284.8	3.3
Grazing Allotment	PNT970058	1,490.8	253.7	17.0
Grazing Lease	GRL33163	63.3	0.1	0.1
Sand and Gravel Quarry	DRS810028	27.3	7.8	28.7
Well site	MSL781267	1.9	1.8	97.0
Sump site	MSL130225	0.8	0.0	1.2
Miscellaneous Lease (Film Industry)	DML920078	6.5	2.2	33.9
Spray Lake Forest Management Area	NA	284,745.5	765.9	0.3

Source: AEP 2017a

Changes to Recreational Use

Construction-phase activities including clearing and construction of MC1-related infrastructure would disrupt access to PRAs and other recreational use areas and displace recreational users.

The batch plant and aggregate area, contractors' shops, work camp, offices, and a warehouse would be constructed in the McLean Creek PRA, and the access road into the PRA would be used for construction access. A portion of McLean Creek outside of the PRA would be diverted, and the dam would be placed to the north of the PRA. The auxiliary spillway and borrow areas are also located in the PRA. The Option design assumes that a portion of the campground would require closure and removal. The campground store is located in the highway realignment, and would also be closed and relocated. Access to McLean Pond day use area, which is adjacent to the MC1 Option area, would be disrupted during construction. Trails in the PRA and trail and road connections to the adjacent OHV PLUZ may also require temporary closure and relocation.

Elbow River PRA does not overlap with the physical dam components; however, portions of the PRA are in the reservoir boundary, including the day use area at Station Flats, Paddy's Flat Campground, and River Cove Group Use Campground. As a result, the Option design assumes the River Cove group campground and Station Flats day use area would be closed and removed for public safety. Paddy's Flat campground would remain, but access would be interrupted during highway relocation. Access to Gooseberry PRA would be affected by relocation of Highway 66. The Option design proposes that the EVRS, which is also affected by the reservoir boundary, be relocated to Gooseberry PRA. Highway and facility relocation would also disrupt access to the Elbow Visitor Information Centre at Gooseberry PRA during the Construction

phase. Recreational access to PRAs farther upstream (e.g., Elbow River Boat Launch PRA), campgrounds, and day use areas such as Elbow Falls and Beaver Flats would likely be delayed or disrupted during relocation of the highway and bridge construction. Access to Camp Horizon (REC2811) would also be disrupted during construction and relocation of the highway.

Non-motorized trails used by mountain bikers, hikers, and horseback riders would be disrupted during construction, and trail sections that fall within the MC1 Option area are likely to require relocation. Highway 66 relocation would temporarily cut off access to the trail network on the north side of the river. During the Operation and Maintenance phase, trail users would need to travel farther upstream to the relocated bridge crossing to access these trails at new access points. On the south side of the river, access to the OHV trails in McLean Creek PRA would be affected. Access gates at McLean Creek PRA and Gooseberry PRA would be closed for construction, and access roads may require relocation. After construction, Highway 66 would be relocated farther south in McLean Creek OHV PLUZ, which would displace OHV use from the new right-of-way and necessitate relocation of OHV use areas.

Catch and release fishing for trout and whitefish is identified as a popular activity in the Elbow River and tributaries, as well as in stocked ponds in the area (Bragg Creek & Kananaskis Outdoor Recreation Ltd. 2014, Government of Alberta 2017d). Due to construction activities, fishing opportunities in the Elbow River mainstem are likely to be reduced in the LAA. Construction activities are likely to include removal of fish habitat due to placement of dam components, changes to channel morphology due to the permanent pond, and realignment of watercourses. These changes may adversely affect fish community composition upstream of MC1 during the Operation and Maintenance phase, thus adversely affect recreational fisheries in the Elbow River over the long term. Further information on potential effects to fish and mitigation measures are provided in **Section 7.3 Aquatic Environment**.

Paddling activities including kayaking, canoeing and whitewater rafting are popular activities in the Elbow River. The placement of the dam would alter flows and water levels due to the permanent pond and dam. No changes are likely to channel morphology upstream of the reservoir boundary; consequently, no changes to whitewater paddling activities are likely. The dam would permanently obstruct navigation of the river and may affect water activities downstream.

The context of current land use in the LAA is considered to be developed due to past and current resource activities; however, competing land use conflicts are identified. For example, ongoing forestry activities in the area have removed portions of popular recreational trails, which are rebuilt or relocated when harvesting is completed (Bragg Creek n.d.). Development of natural gas well sites and infrastructure in the Moose Mountain area north of the LAA has also created concern amongst recreational users and community groups about adverse effects to recreational areas (Bragg Creek Environmental Coalition 2004). Use of OHVs on non-designated trails has also been described as an issue in terms of damage to sensitive areas and deactivated resource roads (Alberta Views 2013, CBC 2016). The LAA is within a 45-minute drive of

the City of Calgary, and visitor use is already high in the area; further, demand for recreational uses of the area is likely to increase as the population of Calgary and adjacent areas increases (Elbow River Watershed Partnership 2009).

In summary, current recreational use is identified as high in the region, and some conflicts already exist between resource interests and recreational users as well as between different groups of recreational users. Loss of recreational areas and subsequent changes to patterns of use are considered likely to place increased pressure on other recreation areas in the Elbow River Valley. Since the area is within a 45-minute drive of the City of Calgary and visitor use is already high in the area, demand for recreational uses of the area is anticipated to increase as the population of Calgary and adjacent areas increases (Elbow River Watershed Partnership 2009). Notwithstanding the potential positive effect on recreational use from construction of the permanent pond, the loss of campsites, day use areas, trails, and changes to the river itself are considered likely to contribute to the potential adverse effect on recreational use.

Changes to Hunting and Trapping Activities

The LAA is part of WMUs 406 (Elbow) and 312 (Priddis). Regulations for WMU 406 include seasons for mule deer, white-tailed deer, moose, elk, black bear, cougar, and game birds (Government of Alberta 2016c). As previously noted, hunting occurs in forest reserve lands in the LAA and may also occur in private parcels, but is assumed to be of low intensity due to the high levels of hiking, mountain biking, camping, and other recreational activities in PRAs and in adjacent forest reserve lands (Jelsoft Enterprises 2017).

The locations of trap lines are unknown; consequently, the extent of trapping activity in the LAA that may be disturbed or displaced by the Construction and Operation and Maintenance phases is not known.

Change in the Quality of the Recreational Experience

During the Construction phase, recreational users in the LAA would likely be affected by MC1-related noise and airborne dust from equipment in use at the work site, and from construction traffic using Highway 66 and other access roads. The construction camp would be in McLean Creek PRA and would likely have a capacity for 100 workers. Traffic to and from the work camp and construction site would contribute to increased traffic in the LAA during the Construction phase. Workers staying at the camp may choose to stay in the LAA for recreation in between shifts, which could temporarily increase demand on local trail networks and other parks facilities. Public health and safety related to dust, noise, and MC1-related traffic is discussed in **Section 8.3 Public Health and Safety.** Public use of the MC1 Option area would be restricted during the Construction phase, but recreational users using the highway and in day use areas and campsites upstream of the Option may experience a reduced quality of recreational experience due to increased noise, dust, traffic, detours and visual effects of construction. Trail users would be able to access the non-motorized trail network from the north.

During the Operation and Maintenance phase, the quality of the recreational experience may be enhanced for some recreational users due to the creation of the permanent pond, if this feature allows for expanded recreational use. However, the reduced area available for camping, hiking, and other activities due to the permanent pond and dam components may lead to increased demand on remaining campgrounds and day use areas. Since recreational use of the Elbow River valley is already high, increased use of day use areas and campgrounds may adversely affect the quality of the experience for some users of existing facilities. The potential effect is adverse, because of a decreased quality of experience during construction, and potential increased demand causing pressure on remaining recreational use areas after the Construction phase.

Disruption of Infrastructure

During the Construction phase, permanent and seasonal residences, parks and fire base operations in the EVRS complex would require closure and relocation. In peak season, the EVRS complex housed up to 150 people, including parks and forestry employees. The financial cost of closure and relocation is discussed in **Section 8.2 Socio-economic Assessment**. Depending on the level of use of the EVRS, relocation could have an adverse effect on parks operations until the new location is functional. The relocated facility would be upgraded to be more modern, which could benefit EVRS and fire base activities.

Other infrastructure in the MC1 Option area and LAA would be affected by Construction-phase activities. The McLean Creek Campground store would be closed and relocated for the Construction phase, as noted above in the discussion of changes to recreational use. In addition, the Elbow Valley Visitor's Information Centre adjacent to Gooseberry PRA may experience disruptions in access during construction, especially during relocation of Highway 66. Increased noise, dust and air emissions, as well as temporary road closures, construction traffic and detours are likely to affect access to and use of parks infrastructure. Infrastructure associated with campgrounds and day use areas in McLean Creek PRA and Elbow River PRA would need to be relocated.

In addition, linear infrastructure would need to be relocated to allow for construction of the dam components, including powerlines that currently cross the site of the dam, auxiliary spillway, and permanent pond. Gas pipelines also cross the LAA in two locations (**Figure 8.1-9**). Pipelines and powerlines that overlap with permanent Option structures (e.g., dam and spillway) would require relocation.

The potential effect would be adverse, until the relocated infrastructure is in operation. Relocation of such infrastructure would likely avoid long term or substantive effects.

8.1.3.3 Mitigation and Enhancement Measures

Mitigation measures comprise any practical means taken to manage potential adverse effects, and may include applicable standards, guidelines, and best management practices (BMPs) supported by specific guidance documents. Mitigation measures to address potential effects are described below and summarized in **Table 8.1-17.** The final column in the table identifies whether there is the potential for a residual effect. In accordance with Alberta Transportation standard practice, BMPs and standard mitigation measures would be included in the Environmental Construction Operations (ECO) Plan Framework that would be developed by the contractor and reviewed by Alberta Transportation prior to the start of construction. The selection of mitigation measures was informed by a review of mitigation measures and follow-up programs, including mitigation undertaken for past projects.

Identify Alternative Areas to Offset Loss of Protected Areas

The Option design includes recommendations for alternative areas to offset loss of portions of affected PRAs. McLean Creek Campground, River Cove Group Use Campground, Station Flats day use area and other infrastructure in affected PRAs (e.g., day use parking, picnic areas, interpretive trails, and toilet facilities) would be relocated to these identified alternative areas. This measure would partially mitigate the following potential adverse effects:

- Changes to protected areas
- Changes in recreational use
- Change in the quality of the recreational experience
- Disruption of infrastructure.

Once the relocated facilities are open to the public, the new recreation areas would reduce the magnitude of the potential adverse effects on recreational use and infrastructure.

Retain or Reconstruct Access to Affected Recreation Areas

The Option design recommends constructing new access to McLean Creek trail. Access to Paddy's Flat campground would also require new access after highway relocation. Where possible, access points to recreation areas can be retained or reconstructed as soon as possible. This measure partially mitigates the potential adverse effects of changes to protected areas, changes in recreational use and change in the quality of the recreational experience.

Many recreational use areas in the LAA are currently accessed by Highway 66. The relocation of the highway would remove access to portions of PRAs and portions of trail networks, unless access is maintained on the north side of the river. Retaining or reconstructing an access road would also restore direct access from the south to the non-motorized trail network. Additional work would be done during

detailed Option design to confirm effects to specific trails and other areas, and confirm the effectiveness of mitigation.

Redirect Recreational Users to Other Recreational Use Areas

Recreational users could be redirected to Beaver Flats and Little Elbow Campgrounds, which are both seasonal campgrounds located farther upstream from the MC1 Option area. Provincial campgrounds are throughout Kananaskis Country, including campgrounds in the Ghost Lake and Sibbald Lake areas, near Cochrane (Government of Alberta 2017j). Ing's Mine Cobble Flats, Moose Mountain Trailhead, and West Bragg Creek are other day use PRAs in Kananaskis Country outside of the RAA. Other provincial campgrounds and day use areas in Kananaskis Country are situated farther from the City of Calgary and other major population areas than the Elbow River PRAs. This measure partially mitigates the following potential adverse effects of changes in recreational use and change in the quality of the recreational experience.

Create a Recreation Site Associated with the Permanent Pond

Over the long-term, creation of a new recreation site to encourage recreational use of the permanent pond may compensate for part of the potential adverse effects on recreational use. However, use of the pond as a recreation feature would need to be carefully managed to protect public health and safety (refer to **Section 8.3 Public Health and Safety** for further information). This measure would partially mitigate potential adverse effects that include changes in recreational use and change in the quality of the recreational experience. Additional work would be done during detailed Option design to confirm the suitability of this mitigation measure.

Establish and Maintain Signage at Affected Recreational Use Areas

Prior to and during MC1 construction activities, establish and maintain signage at affected recreational use areas, including staging areas and trailheads. Signage would include information about closures of trails and other recreational features, timing of closures, potential detours and contacts for further information. Signage could also be placed on access roads near construction activities notifying road users of activities that are taking place. This measure partially mitigates the potential adverse effects of changes in recreational use and change in the quality of the recreational experience.

Communicate Option Construction Schedule and Road Closure Schedules

Communication of the MC1 construction schedule and road closure information to stakeholders, both prior to and during the Construction phase, partially mitigates the potential adverse effects of changes in recreational use and change in the quality of the recreational experience.

Communications could include placing weekly announcements in local papers and on relevant websites (e.g., 511 Alberta) to notify the public of the location and timing of construction activities and notification of formal closures as well as areas that would not be available for use. Information could also be provided on alternative use areas, in order to mitigate adverse effects on recreational users and quality of experience.

Consultation with Hunters

Consultation with hunters and guide outfitters that use the MC1 Option area (e.g., fish and game association in the Calgary area) would help to determine the intensity of use of the area for hunting and any specific mitigation measures that may be required.

Consultation with Disposition Holders

Consultation with disposition holders to resolve specific issues related to dispositions may partially mitigate the potential adverse effect of changes to resource and commercial use. Information such as construction schedule, road closure schedule, location of permanent and temporary disturbance relative to areas of resource use is likely to assist in the identification of specific mitigation measures.

Develop Traffic Accommodation Strategy

The Traffic Accommodation Strategy would be developed in consultation with stakeholders and government agencies. Measures would likely include notification and signage regarding road closures, potential detour routes and standards and regulations for construction traffic. The Traffic Accommodation Strategy would partially mitigate the following potential adverse effects of changes in recreational use, change in the quality of the recreational experience and changes to resource and commercial use.

Compensation Program for Grazing Allotment Holders

Compensation to grazing allotment holders for permanent removal of portions of grazing allotments, where applicable, would partially mitigate potential changes to resource and commercial use. The details of a compensation program would be addressed during detailed MC1 design.

Communicate with and Compensate Registered Fur Management Area Holders

Consultation with the Alberta Trappers' Association and individual meetings with trappers would take place to enable trappers to move traplines and/or set new lines away from the MC1 area. Provision of compensation to RFMA holders according to the Alberta Trapper's Compensation Programme, as necessary, has been identified to partially mitigate potential change in trapping activities (Alberta Trappers' Association 2017). The extent of MC1-related effects on RFMA holders is currently unknown; however, if effects to existing RFMA are identified, application of this measure would partially mitigate this potential adverse effect.

Develop and Implement Plan for Infrastructure Relocation

MC1 design recommends relocating the EVRS to Gooseberry PRA, and relocating McLean campground to a suitable alternative location. Working with the Government of Alberta to develop and implement a plan for decommissioning, and relocating and rebuilding infrastructure would partially mitigate the potential adverse effect of disruption of infrastructure.

Table 8.1-17 Summary of Potential Effects and Mitigation Measures for Land Use and Management

Summary of Potential Effect	Option Phase	Contributing Option Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Changes to Protected Areas	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	· Identify alternative areas to offset loss of protected areas · Retain or reconstruct access to affected recreation areas	Yes
Changes to Resource and Commercial Use	Construction Operation and Maintenance	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	· Communicate MC1 construction schedule and road closure schedules · Consult with disposition holders · Develop and implement Traffic Accommodation Strategy · Compensation program for grazing allotment holders	Yes
Changes to Recreational Use	Construction Operation and Maintenance	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	· Identify alternative areas to offset loss of protected areas · Retain or reconstruct access to affected recreation areas · Redirect recreational users to other recreational use areas · Create a recreation site associated with the permanent pond · Establish and maintain signage at affected recreational use areas	Yes

Summary of Potential Effect	Option Phase	Contributing Option Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
			· Communicate MC1 construction schedule and road closure schedules · Develop and implement Traffic Accommodation Strategy	
Changes to Hunting and Trapping Activities	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	· Communicate MC1 construction schedule and road closure schedules · Consultation with hunters · Communicate with and compensate RFMA holders	No
Change in the Quality of the Recreational Experience	Construction Operation and Maintenance	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	· Redirect recreational users to other recreational use areas · Create a recreation site associated with the permanent pond · Establish and maintain signage at affected recreational use areas · Communicate MC1 construction schedule and road closure schedules · Develop and implement Traffic Accommodation Strategy	Yes
Disruption of Infrastructure	Construction	New Parks infrastructure construction	· Develop and implement plan for infrastructure relocation	Yes

8.1.3.4 Residual Effects

Residual effects are MC1-related effects that are anticipated to occur to VCs after the application of mitigation measures. This section describes how the residual effects of the Option are characterized and summarized for the Land Use and Management VC. An overview of post-mitigation (residual) effects is provided in **Table 8.1-17**. Residual effects are characterized based on the criteria defined in **Table 8.1-18**.

Potential MC1-related residual effects are delineated as:

- Non-substantive residual effect – mitigation measures have not fully eliminated the effects, but have reduced the magnitude, extent, or duration to such a degree as to avoid a substantive effect on the VC. This characterization is based on the definitions and rating of effects characteristics outlined in **Table 8.1-18**.
- Substantive residual effect – adverse effects are predicted to have be major in magnitude, regional in extent, or long-term in duration even after implementation of mitigation.

Table 8.1-18 Residual Effects Characteristics for Land Use and Management

Residual Effect Characteristic	Rating	Definition
Direction	Positive	The trend of the effect is considered desirable or an improvement from baseline conditions
	Adverse	The trend of the effect is considered undesirable or worsening from baseline conditions
Extent	Local	Limited to the LAA
	Regional	Limited to the RAA
Magnitude	Negligible	No detectable change to land use and management from baseline conditions
	Minor	Change in land use and management is detectable; however, effect would be limited to an inconvenience or nuisance change.
	Moderate	Change in land use and management is detectable and would result in a moderate change to land use or management.
	Major	Change in land use and management is large enough to result in a severe change to land use or management.
Duration	Short-term	Effect would occur during Construction phase
	Long-term	Effect would extend through the Operation and Maintenance phase
Reversibility	Reversible	Effect could be reversed once the activity causing the residual effect ceases
	Not reversible	Effect would be permanent
Frequency	Isolated	Effect would occur once
	Periodic	Effect would occur intermittently and repeatedly
	Continuous	Effect would occur continuously
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to the MC1 Option area
	Moderate	Rating predictions are based on a good understanding of cause-effect relationships relying on data from elsewhere, or incomplete understanding of cause-effect relationships from data specific to the Option.
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Changes to Protected Areas

Provincial Recreation Areas are established on public lands to provide access and staging areas for recreational uses, and to protect significant natural, cultural, and scenic values (Government of Alberta 2012). The changes to PRAs after mitigation is applied constitute a non-substantive, adverse MC1-related effect to protected areas affected by the Option. A portion of McLean Creek campground would be permanently closed and relocated. River Cove Group Campground and Station Flats day use area in Elbow River PRA are affected by the reservoir boundary and are likely to be permanently closed and relocated for public safety reasons. Paddy's Flat campground and McLean Creek campground are likely to be closed for the duration of the Construction phase, due to Option noise and air quality concerns (**Section 6.1 Atmospheric Environment**).

The residual effect would be limited to the LAA in extent, short-term, and not reversible. Relocation of features including campgrounds and day use areas to alternative areas is likely take place during construction, and the remaining areas in McLean Creek and Elbow River PRA are likely to be fully accessible once the Construction phase is complete. Relocation of affected areas would partially mitigate the adverse effect; however, the magnitude of the potential effect after mitigation measures are applied is moderate because the effect constitutes a permanent loss of protected PRAs. Confidence in the rating predictions are high due to information provided in the Option design, and understanding of cause-effect relationships specific to the MC1 Option area. The residual effects characteristics for changes to protected areas are summarized in **Table 8.1-19.**

Table 8.1-19 Summary of Effect Characteristics Ratings for Changes to Protected Areas

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Loss of designated protected areas
Extent	Local	Disturbed areas limited to LAA
Magnitude	Moderate	Permanent loss of PRAs would constitute a moderate modification to the human environment
Duration	Short term	With effective mitigation, effect would be confined to Construction phase.
Reversibility	Not reversible	Loss of PRAs would be permanent.
Frequency	Isolated	Loss of PRAs would occur once
Confidence	High	Cause-effect relationship is clear, based on specific Option data and generally well understood.

Changes to Resource and Commercial Uses

The change in resource and commercial uses would constitute a non-substantive adverse effect on disposition lease holders, including use of a sand and gravel quarry, forest harvesting activities in FMU 10, and grazing activities on grazing allotments. The magnitude of the potential effect would be moderate, but confidence in the evaluation is moderate. The extent of current and scheduled forest harvesting and grazing

activities in the LAA appears to be minor, but requires field verification or consultation. The level of use in identified dispositions and other resource areas has also not been confirmed with resource users. The duration of the effect would be short-term, and the potential reduction in timber yields and loss of grazing areas would be considered to be reversible if other areas are available to offset losses, or through a compensation mechanism, as appropriate.

Early consultation with disposition holders, forestry companies, and grazing allotment holders and compensation for lost revenues, as appropriate may partially mitigate the change in resource and commercial use. The development and implementation of a Traffic Accommodation Strategy would help reduce delays and disruption in access for resource users and commercial interests. Relocation of resource activities to similar areas in the region, and compensation to disposition holders would also partially mitigate the adverse effect (**Section 8.1.3.3**). The residual effects characteristics for the changes to resource and commercial uses are summarized in **Table 8.1-20**.

Table 8.1-20 Summary of Effect Characteristics Ratings for Changes to Resource and Commercial Uses

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Loss of lands in FMA, grazing allotments and quarry operation.
Extent	Local	Disturbed areas limited to LAA.
Magnitude	Moderate	Displacement of resource activities would constitute a moderate modification to the human environment.
Duration	Short-term	Effect would occur during Construction phase.
Reversibility	Reversible	Losses to resource use may be mitigated through offsets or compensation mechanism.
Frequency	Isolated	Loss of resource use areas would occur once.
Confidence	Moderate	The intensity of resource activities in the LAA appears to be minor, but would require field verification or consultation.

Reduction to Recreational Use

The physical disruption by the MC1 Option would displace recreational activities including camping, day use, sightseeing, hiking, mountain biking, OHVs, horseback riding, paddling, rafting, fishing, and winter activities in the LAA for the duration of the Construction phase. Portions of recreational use areas would be partially displaced, and recreational use would potentially be reduced in the LAA after the dam is commissioned (i.e., during the Operation and Maintenance phase). Mitigation measures would help to reduce the potential effect, including: relocation of PRAs; retaining access to and use of remaining recreation areas; redirection to unaffected PRAs; updated signage referencing Option activities at access points; ongoing communication with stakeholders; and implementation of a Traffic Accommodation Strategy (**Section 8.1.3.3**).

Although the creation of a recreational site associated with the permanent pond (**Section 8.1.3.3**) may enhance some recreational opportunities in the LAA in the long-term, the loss of campsites, day use areas, non-motorized and OHV trails and changes to the Elbow River itself affecting fishing and water-based recreation are considered to contribute to a substantive adverse effect on recreational use.

In addition, the adverse effect would be regional in extent. Access to recreational areas in the LAA, RAA and other recreational use areas upstream of the Option would be disrupted during the Construction phase, due to road closures and delays. Access roads to remaining recreational areas such as Paddy's Flat campground and McLean Pond may require relocation. In addition, access to Camp Horizon (REC2811), which is a private campsite and convention centre complex, would be disrupted during construction and relocation of the highway. Noise, dust and emissions during construction would also affect recreational use of the LAA. Closure of McLean Creek campground, Easter Seals Camp Horizon and Paddy's Flat campground is recommended for the duration of construction in **Section 6.1 Atmospheric Environment.** River Cove Group Campground and Station Flat's day use area in Elbow River PRA would be permanently closed and facilities would be relocated.

After implementation of mitigation, the magnitude of the adverse effect is considered to be major. The permanent removal of protected and unprotected recreation areas may be partially mitigated through provision of alternative areas, but the adverse effects on OHV and non-motorized trails, changes to fishing opportunities and loss of highly popular campgrounds and day use areas would remain. Whitewater opportunities upstream of Elbow River Boat Launch PRA are not likely to be adversely affected, but river use downstream of the Option would change due to placement of the dam and the permanent pond obstructing navigation down the river.

Although PRAs are identified for recreational uses and some protection, surrounding forest reserve lands are shared by recreational users and resource interests. The adverse effect on recreational use would likely to extend outside of the LAA to include upstream and downstream areas of the RAA, due to displacement of recreational users. Displaced users may in turn cause pressure on other campgrounds and day use areas in Kananaskis Country. The duration of the effect is long-term, extending through the Operation and Maintenance phase, and not reversible. Although alternative areas may be found, the character of the Elbow River and surrounding lands would be permanently altered. Confidence in the rating of this adverse effect is considered moderate; however, further information would fully characterize the residual effect, including:

- Additional information on the level of recreational use in the LAA, including water-based activities;
- The nature of disturbance to non-motorized and OHV trail networks; and
- Identification of candidate areas to offset losses to PRAs.

The residual effects characteristics for the change in recreational use are summarized in **Table 8.1-21**.

Table 8.1-21 Summary of Effect Characteristics Ratings for Reduction to Recreational Use

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Loss of areas used for multiple recreation activities
Extent	Regional	Effects would extend to RAA
Magnitude	Major	Effect would cause a severe modification to the human environment after mitigation, including extensive closures of popular OHV and non-motorized trails, changes to fishing opportunities, and loss of highly popular campgrounds and day use areas.
Duration	Long-term	Extends through Operation and Maintenance phase
Reversibility	Not reversible	Substituted areas may not fully compensate for losses
Frequency	Continuous	Loss of recreational use
Confidence	Moderate	Cause-effect relationship is clear and well understood, although further detail on the nature of disturbance to trails (OHV and non-motorized) and day use areas as well as location of candidate replacement areas for recreational users would improve understanding

Change in the Quality of the Recreational Experience

During the Construction phase, nuisance factors including noise, air emissions, dust, and visual effects of construction may contribute to a reduced quality of recreational experience for recreational users in the LAA. Access to recreational use areas would be restricted in the LAA during the Construction phase. Recreational users passing through the LAA may also have a transitory reduced quality of experience, both due to nuisance factors and potential traffic delays. During the Operation and Maintenance phase, the reduced area available for camping, hiking, and other activities may lead to increased demand on remaining areas, both inside and outside the RAA, which could cause a decrease in the quality of the experience for some users until alternative areas are available for use. A new recreational site at the permanent pond (**Section 8.1.3.3**) may have a positive effect during the Operation and Maintenance phase by increasing recreational opportunities in the area. The potential effect is considered to be non-substantive and moderate in magnitude, and the direction is both positive (i.e., increased quality of experience associated with the new pond) and adverse (i.e., decreased quality of experience during construction, potential increased demand of remaining use areas after construction). Redirecting recreational users to other areas (**Section 8.1.3.3** may decrease the adverse effect during construction. Signage, communications with stakeholders, and implementation of a Traffic Accommodation Strategy would also help to reduce the adverse effect (**Section 8.1.3.3**). The residual effects characteristics for the change in the quality of the recreational experience are summarized in **Table 8.1-22**.

Table 8.1-22 Summary of Effect Characteristics Ratings for Change in Quality of Recreational Experience

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse Positive	Adverse effect due to nuisance factors and traffic delays during construction Positive effect due to creation of permanent pond
Extent	Local and Regional	Nuisance factors restricted to LAA Operation and Maintenance-phase effects in LAA and RAA
Magnitude	Moderate	Effects to quality of recreational experience would constitute a moderate modification to the human environment
Duration	Long-term	Effects would extend into Operation and Maintenance phase
Reversibility	Reversible	Adverse effects would be likely to decrease during Operation and Maintenance phase
Frequency	Continuous	Decreased quality of experience would be a continuous effect
Confidence	High	There is a good understanding on how the MC1 Option would affect the quality of recreational experience.

Disruption of Infrastructure

Depending on the level of use of the EVRS, the adverse effect is considered to be non-substantive and moderate over the short-term, until the relocated and rebuilt ranger station and firefighting base can resume operation (**Section 8.1.2.6**). The relocated facility is likely to be in Gooseberry PRA. It is likely that relocated facilities would be upgraded to be more modern, which could benefit ranger station and fire base activities over the long term. Other infrastructure that would require relocation include pipelines and transmission lines affected by the placement of dam components (**Section 8.1.3.2**).

The potential effect would be adverse in direction and moderate in magnitude during relocation and reconstruction, and would be considered fully mitigated once the relocated infrastructure is in operation. Relocation of the infrastructure would likely avoid long term or substantive effects. The residual effects characteristics for disruption of infrastructure are summarized in **Table 8.1-23**.

Table 8.1-23 Summary of Effect Characteristics Ratings for Disruption of Infrastructure

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Disruption of EVRS and fire base activities
Extent	Local	Limited to the LAA
Magnitude	Moderate	Disruption of infrastructure would constitute a moderate modification to the human environment
Duration	Short-term	Effect would occur during Construction phase
Reversibility	Reversible	Infrastructure would be relocated
Frequency	Isolated	Closure and relocation of infrastructure would occur once
Confidence	High	There is a good understanding on how the Option would affect infrastructure in the LAA

8.1.3.5 Summary of Land Use and Management Assessment

Five residual effects would be likely to occur related to Land Use and Management. The residual effect of reduction to recreational use is considered to be substantive.

Although mitigation measures such as relocation of campgrounds, trails, and day use areas and restoration of access to remaining areas would partially mitigate the adverse effect on recreational use, the residual changes to recreational use constitute a substantive adverse effect and a severe modification to the human environment. The change to recreational use would include extensive closures of popular OHV and non-motorized trails, changes to fishing opportunities, and loss of popular campgrounds and day use areas. Due to the permanent changes that would occur in the Elbow River Valley on PRAs and other unprotected recreational use areas, in the context of the high level of intensity of recreational use that the LAA currently receives, the effect on recreational use is considered to remain major.

The changes to protected areas, changes to resource and commercial uses, change in quality of the recreational experience and disruption to infrastructure are identified as non-substantive adverse effects that constitute a moderate change to land use.

The substantive residual effect: changes to recreational use is carried forward for consideration in the cumulative effects assessment (**Section 9.0 Planned Development Case**)**.**

8.1.4 FOLLOW-UP MONITORING FOR LAND USE AND MANAGEMENT

Although the effects of the MC1 Option would be partially addressed by mitigation measures described in **Section 8.1.3.3**, the effects assessment predictions are based on publicly available data which may be incomplete. In addition, changes to existing land use and management may produce new Option interactions. Finally, proposed mitigation measures may need to adapt to changing conditions. Monitoring programs provide a means to gain certainty in predicted MC1-related effects and determine the effectiveness of mitigation measures. Proposed objectives of the land use and management monitoring program framework include:

- Monitor and verify potential land use and management effects related to the MC1 Option;
- Monitor and evaluate the effectiveness of mitigation measures;
- Identify unanticipated MC1-related effects;
- Discern MC1-related changes from other industrial or commercial activities in the LAA; and
- Inform adaptive management measures.

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8.2 SOCIO-ECONOMIC RESOURCES

This section presents a discussion of potential socio-economic effects from MC1-related disturbances to the Socio-economic Resources Valued Component (VC). For the purposes of this assessment, socio-economics is defined as the interactions between social and economic factors and the Elbow River at McLean Creek Dam (MC1) Option, and specifically how economic activity is shaped by social processes. The MC1 Option would generate economic activity and would interact with local and regional economies and the regional labour market.

8.2.1 SCOPE OF ASSESSMENT

This section presents a summary of the scope of the assessment for Socio-economic Resources, and includes the relevant regulatory framework, data sources, measurable parameters, and assessment boundaries. The assessment of MC1-related effects on Socio-economic Resources relies on information compiled through a review of publicly available literature as well as the results of past and current studies completed for MC1.

8.2.1.1 Regulatory Framework

The MC1 site is located on the Elbow River in the Green Zone on Crown land, approximately 10 kilometers (km) southwest of the town of Bragg Creek in the Kananaskis Improvement District (KID). Legislation applicable to the socio-economic assessment are provided in **Table 8.2-1**.

Table 8.2-1 Summary of Applicable Regulatory and Policy Framework for Socio-economic Resources

Legislation Name	Jurisdiction	Description
Municipal Government Act, RSA 2000, c.M-26	Provincial	MC1 is located in the KID, which was established pursuant to the Municipal Government Act in 1996. The KID provides local government and municipal services to the residents of Kananaskis Country.
Land Stewardship Act, 2009, c. A-26.8	Provincial	This legislation enacts regional land use planning, which defines regional outcomes (economic, environmental, and social), and establishes the legal basis for the development of regional plans. It provides regulations concerning the implementation of regional plans under the Alberta Land Use Framework (LUF). For example, the South Saskatchewan Regional Plan was developed under the Alberta LUF, and applies to MC1.

Land use policies and resource management objectives provide direction for economic activities and strategic planning guidance for economic development. **Section 8.1** describes the regional context for MC1-related land use planning and policies.

8.2.1.2 Data Sources

This assessment relies on information compiled from a review of publicly available literature as well as previous and new studies conducted for MC1. Data sources that informed the assessment of effects on Socio-economic Resources include MC1-specific data, as well as data collected for the Springbank Offstream Reservoir Project (SR1 Project), government databases, government planning documents and reports, and other publicly available literature. The data sources reviewed included:

- Environmental Overview of the Conceptual Elbow River Dam at McLean Creek (AMEC 2015)
- Recommendations on the Elbow River: Major Infrastructure Decisions (AEP 2015)
- Review of Two Flood Mitigation Projects: Bragg Creek / Springbank offstream flood storage and McLean Creek flood storage (Deltares 2015)
- Benefit/Cost Analysis of Flood Mitigation Projects for the City of Calgary: McLean Creek Flood Storage (IBI Group 2015)
- Elbow River Basin Water Management Plan (Elbow River Watershed Partnership 2009)
- South Saskatchewan Regional Plan: 2014 – 2024 (Government of Alberta 2017a)
- Kananaskis Country Provincial Recreation Areas and Bragg Creek Provincial Park Management Plan (Government of Alberta 2012)
- Greater Bragg Creek Area Structure Plan, Bylaw C-6260-2006 (Rocky View County 2007)
- Statistics Canada (2006, 2011, 2016 Census Profiles, 2011 National Household Survey).

Statistical data, provided by the Statistics Canada Census Program, are subject to limitations including inconsistencies associated with non-response rates and random rounding for confidentiality purposes, and the ephemeral nature of socio-economic conditions. For example, population and demographics were provided in the 2011 Census Profiles while education, labour, and income were provided in the 2011 National Household Survey (NHS). In previous Census years (e.g., 2001 and 2006), statistical data for these topics were provided in the Census Profiles. The NHS is a new data product implemented during the 2011 Census cycle, and is a voluntary survey that replaced the former mandatory long-form Census (Statistics Canada 2013). Overall, the NHS achieved a national response rate of 69 percent (%), compared to 97% for the 2011 Census (Statistics Canada 2015). Due to the voluntary nature of the NHS survey, it is also subject to potentially higher non-response errors than the Census (Statistics Canada 2013). In most cases, Statistics Canada has not released data for any geographic area with a global non-response rate greater than or equal to 50% (Statistics Canada 2015).

Although weights were applied to reduce or eliminate differences between the underlying total populations for the Census and NHS, Statistics Canada indicates that weighting constraints were sometimes discarded, resulting in discrepancies (Statistics Canada 2013). Statistics Canada advises exercising caution when comparing 2011 NHS data to previous Census data due to data quality and differences between the voluntary survey and the previous long-form questionnaire (Statistics Canada 2013). Although limitations

to the NHS exist, the data product provides one of the few available published statistical data at the community level across the entire study region, as well as an indication of existing conditions and trends.

8.2.1.3 Valued Components

MC1 has the potential for interactions with socio-economic conditions in the region. MC1 activities may interact with provincial and regional economies, and create economic benefits and costs related to employment, contracting and procurement, relocation of infrastructure, and changes to recreational activities. Further, the presence of temporary workers during construction activities may affect local and regional economies, as well as infrastructure and community services through increased demand. Finally, MC1 construction and operation may displace current land use activities and result in changes to current and future economic opportunities. The rationale for the inclusion of the Socio-economic Resources VC in this assessment is provided in **Table 8.2-2.**

Table 8.2-2 Valued Components for Socio-economic Resources

Valued Component	Interaction
Socio-economic Resources	Socio-economic Resources was selected as a VC to assess potential Option interactions with local and regional economies and the regional labour market, to characterize economic activity generated by MC1, and to assess socio-economic effects of relocation of infrastructure and changes to recreational activities.

8.2.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and trends, and evaluate potential MC1-related effects to the VC. Measurable parameters that generate useful data to inform the assessment of potential effects on the Socio-economic Resources VC were selected. As part of the alternate means assessment of the Environmental Impact Assessment process, selected measurable parameters have been used to develop a Baseline Case for the evaluation of potential MC1-related effects and, where required, development of mitigation measures. Due to the size and diversity of the available regional labour pool, MC1 would not likely affect employment training. The relatively short (i.e., 4-year) construction period and MC1's proximity to a large urban area (i.e., City of Calgary) suggests that specialized training programs would not be required to supply workers. In addition, any training programs specific to MC1 would be unlikely to produce adequately trained workers in the timeframe required. Therefore, a change in employment training is not considered a detectable effect and is not assessed.

The measurable parameters selected for the Socio-economic Resources VC are shown in **Table 8.2-3.** Potential adverse MC1-related effects to the Socio-economic Resources VC arising from potential interactions are discussed in more detail in **Table 8.2-2**.

Table 8.2-3 Measurable Parameters for Socio-economic Resources

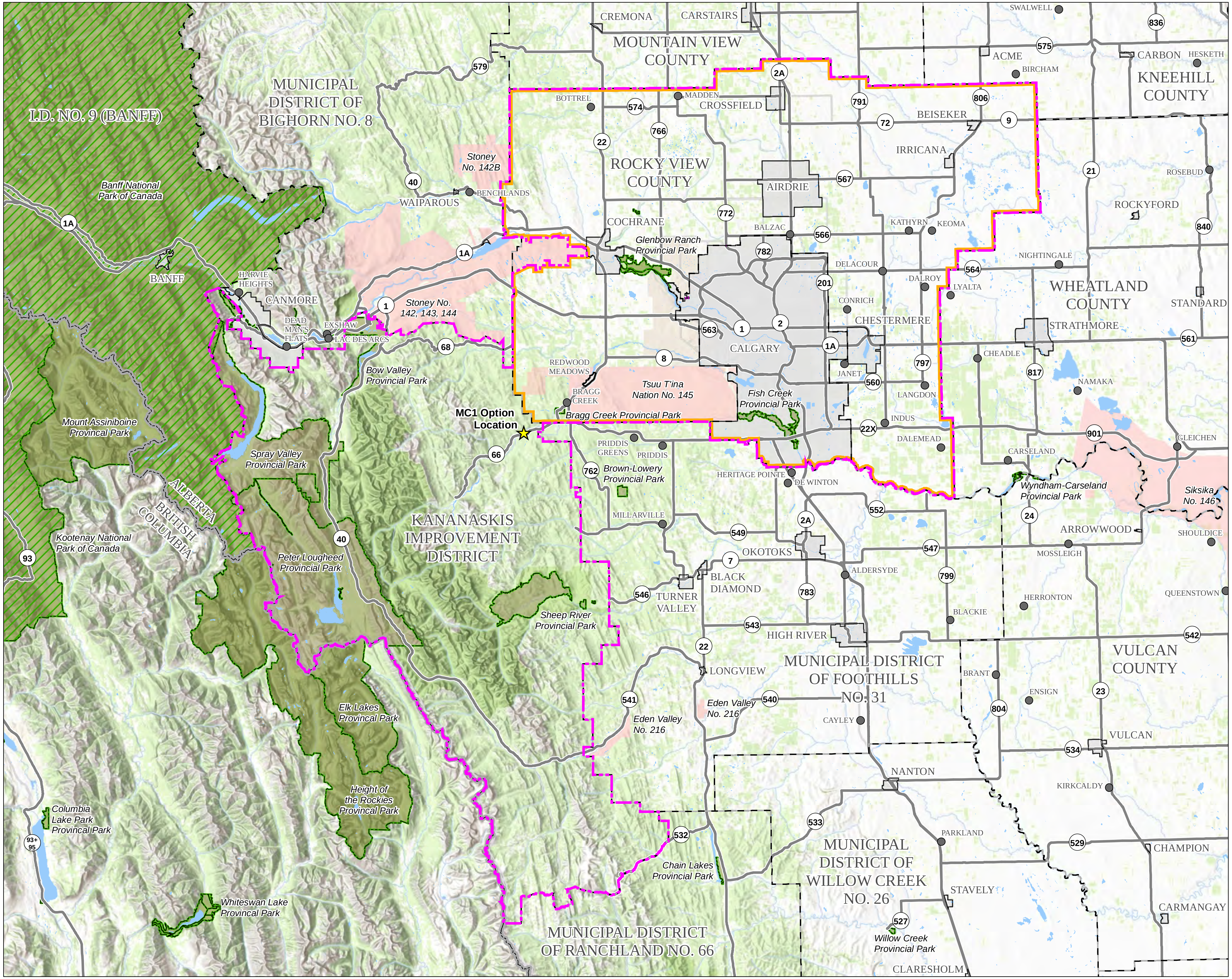
Selected Valued Component	Potential Option Effects	Measurable Parameter
Socio-economic Resources	Change in provincial and regional economies	Gross output, gross domestic product (GDP), labour income, employment
	Change in labour force	Labour capacity, employment rate, participation rate, labour income
	Change in contracting and procurement opportunities	Available contracts and procurement opportunities
	Change in economic activities of resource-dependent businesses and industry	Annual allowable cut and timber harvest volumes, intensity of land and resource use, campground fees
	Change to regional economic conditions	Value of local and regional spending and related employment
	Change in availability of accommodation	Vacancy rates, housing inventory, cost of accommodation
	Change in infrastructure and services	Capacity/demand of regional services (e.g., health and emergency services); capacity/demand of regional infrastructure (e.g., roads, recreational infrastructure)

8.2.1.5 Assessment Boundaries

Spatial Boundaries

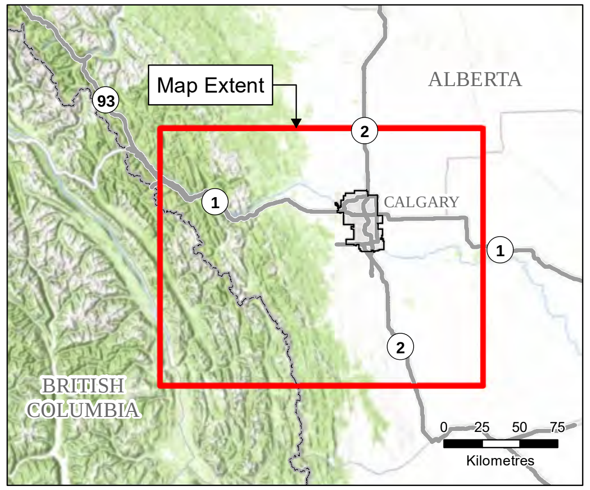
No discrete Local Assessment Area has been defined for this assessment because in this case, the Regional Assessment Area is considered to encompass the maximum geographical area where MC1 is expected to interact with and potentially have a direct or indirect effect on socio-economic conditions, as well as provide an overall regional context. The RAA defines the communities and regions in which people reside who may be affected by MC1, as well as sources of labour and goods and services. The data sources used to inform the assessment are also primarily regional in scope. The RAA also encompasses the area where the residual effects of MC1 are likely to interact with the residual effects of other past, present, or future projects or activities to result in a cumulative effect or effects.

As shown in **Figure 8.2-1** the RAA for the assessment of Socio-economic Resources includes the KID and the Calgary Census Metropolitan Area (CMA). The KID is an agglomeration of parks and Crown lands which is geographically vast but sparsely populated. The Calgary CMA includes the City of Calgary as well as Rocky View County (including the Greater Bragg Creek area), Tsuut'ina Nation 145 Indian Reserve which includes the Townsite of Redwood Meadows, and the communities of Cochrane, Airdrie, Chestermere, Crossfield, Irricana, and Beisecker. The Calgary CMA is likely to be the main source of goods, services, and workers for MC1.



Elbow River at McLean Creek Dam (MC1)

Socio-economic Resources Regional Assessment Area



Legend

- Socio-Economics Resources Local Assessment Area and Regional Assessment Area
- MC1 Option Location
- Hamlet
- Highway
- Provincial Border
- Reserve
- National Park
- Provincial Park
- Calgary Census Metropolitan Area (CMA)
- Municipal Boundary
- Urban Area
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta
- Dam and flood details: Opus International Consultants Limited, 2017
- Borrow Areas: Hatch Ltd., 2017
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Temporal Boundaries

The temporal boundaries identified for the Socio-economic Resources VC assessment encompass periods when MC1 may affect the VC. The Construction and Operation and Maintenance phases comprise the temporal boundaries, which are described in **Section 3.0 Option Description.**

Administrative Boundaries

Administrative boundaries refer to political, economic, or social issues, as well as fiscal or other resourcing issues that constrain the assessment of potential MC1-related effects. The Socio-economic Resources RAA is defined by the KID and Calgary CMA, which are political and administrative boundaries relevant to service provision and governance for communities and residents who may be affected by MC1. The use of these administrative boundaries also aligns with available statistical and other forms of data used to inform this assessment.

Technical Boundaries

The assessment of the Socio-economic Resources VC was informed by economic analysis and desktop research. Stakeholder concerns related to MC1 were not provided; however, every attempt was made to identify the key socio-economic issues associated with the construction and operation of MC1, using professional experience of the assessment team, and considering similar projects recently proposed for flood mitigation in Alberta where stakeholder input was provided. Notwithstanding the technical boundaries as noted, the information in Section 8.2.2 provides an indication of existing conditions and trends, which is considered to adequately inform the effects assessment for Socio-economic Resources.

MC1 may interact with socio-economic interests of Indigenous groups; however, consultation would be required to understand relevant Indigenous groups' interests. No consultation was conducted during the preparation of this assessment; therefore, this assessment is based on desktop research only, and Indigenous groups interests are not included this assessment.

8.2.1.6 Methodology – Economic Modelling

An economic input-output analysis was conducted for MC1 to estimate the effects of its construction and operational expenditures on regional economic conditions, such as contributions to provincial gross domestic product (GDP), employment and labour income. Input-output analysis is based on statistical information about the flow of goods and services among various sectors of the economy. An input-output model provides estimates on the amount of additional production that is generated by a change in the demand for one or more commodities, or by a change in the output of an industry.

The cost estimates used as inputs to the analysis were provided by Opus Stewart Wier Ltd. These cost estimates were then allocated to provincial economic multipliers based on the most recent published data (Government of Alberta 2015). The multipliers were used to estimate the effects of MC1 expenditures on provincial output, GDP, labour income and employment. The multipliers are accompanied by commodity

supply ratios, which represent the aggregated proportion of the supply that comes from within and outside Alberta for each major commodity group.

Input-output analysis is based on various simplifying assumptions:

- Input-output models are linear. They assume that a given change in the demand for a commodity or for the outputs of a given industry will translate into a proportional change in production;
- Input-output models do not take into account the amount of time required for changes to happen. Economic adjustments resulting from a change in demand are assumed to happen immediately;
- It is assumed that there are no capacity constraints so that, for example, an increase in the demand for labour would result in an increase in employment (rather than a redeployment of workers).

The Input-Output model produces estimates of the direct, indirect and induced effects on economic conditions:

- Direct effects result from expenditures that are directly associated with constructing and operating MC1 (e.g., labour, materials, supplies, and capital). The change in provincial and regional economies from MC1 would result in direct effects on GDP, jobs, and imports.
- Indirect effects result from suppliers and contractors purchasing goods and services or hiring employees to meet the demands of MC1. An example would be a hauling company contractor that must hire more drivers due to MC1. Indirect effects include the chain reaction of output up the production stream, which could include the various inputs to produce all the products to meet requirements.
- Induced effects result from Option workers spending part of their wages on goods and services, such as meals, gas and accommodation. Spending at local businesses is likely to have a positive economic effect.

The results of the Input-Output model provide information on the economic impact of MC1's capital expenditures and operational expenditures (i.e., the purchase of goods and services to build and operate MC1), and are used to inform the assessment of economic effects.

8.2.2 BASELINE CASE

Socio-economic factors considered in the Baseline Case for the Socio-Economic Resources VC include:

- Existing socio-economic conditions in the region and in local communities
- Factors that contribute to socio-economic conditions in the region and in local communities, including:
  - population and demographics
  - regional labour market characteristics
  - community and regional infrastructure and services.

The following sections provide a Baseline Case for the Socio-economic Resources VC and is supported by the data compiled from the sources listed in **Section 8.2.1.2**.

8.2.2.1 Provincial Economy

Alberta's provincial economy has led Canada in economic growth during the past 20 years, with the exception of the economic recession from 2014 to 2016 which was acknowledged as one of the most severe the province has ever experienced (CBC News 2016). Following an increase of 0.5% in GDP in 2014, Alberta's GDP contracted by 3.6% to $326.4 billion in 2015 (Alberta Economic Development and Trade 2017). This contraction was largely associated with declines in oil and gas prices and subsequent lower capital investments throughout the oil and gas industry. In 2016, crude oil prices had declined by more than 60% since mid-2014, which is one of the largest declines on record. The economic outlook for the province in 2017 predicts GDP growth of 2.2%, with sources of growth based in agriculture and tourism rather than the energy sector (ATB Financial, Economics and Research 2017). Currently, Alberta's oil and gas sector accounts for 19% of its GDP, with other non-energy sectors, such as construction, finance and real estate, and business and commercial services growing substantially over the last three decades (Alberta Economic Development and Trade 2017).

For 2016 and 2017, Alberta's provincial revenue is projected to be $41.4 billion, 3.7% lower than forecasted in 2015 and 2016 (Government of Alberta 2017b). Provincial revenue collected through income and taxes is estimated to account for approximately half ($21.8 billion) of the current budget. The remaining revenue includes federal transfers ($7.2 billion), premiums, fees and licences ($3.5 billion) investment income and income from government businesses ($2.5 billion), and other sources ($2.8 billion) (Government of Alberta 2017b). Alberta's 2016 fiscal budget includes $51.1 billion in total expenditures for 2016 and 2017. The four largest ministries (Health, Education, Advanced Education, and Human Services) account for 75% of the Province's total expenditures (Government of Alberta 2017c).

8.2.2.2 Regional Economy

The economic conditions within the RAA are reflective of a broad range of sizes and types of communities including the MC1 area on Crown lands within the KID, the small communities of Bragg Creek and Redwood Meadows downstream of MC1 on the Elbow River, and Calgary, Alberta's largest urban area and economic centre (**Figure 8.2-1**). The following subsections describe economic conditions relevant to the RAA, from the broader economic context of the South Saskatchewan Region (SSR) of southern Alberta to the KID, Rocky View County and the Calgary CMA.

South Saskatchewan Region

The RAA is in Alberta's SSR, which is a land-use region that covers much of southern Alberta and includes the cities of Calgary, Lethbridge and Medicine Hat. The SSR provides a larger geographic context for key economic drivers in southern Alberta. This region includes approximately 12.6% of Alberta's total land area

and approximately 44% of its residents (approximately 1.8 million people). The diversified economy includes agriculture, tourism and forestry activities, as well as manufacturing and services to support oil and natural gas development and the technology sector (Government of Alberta 2017a). Agriculture is the primary renewable resource in the SSR. In 2011, farm cash receipts totalled $4.5 billion, out of $10.4 billion for the province. Agricultural activities include crop production, livestock grazing, cattle feedlots, greenhouses, and processing facilities for beef, chicken, dairy products, and vegetables. Forested lands comprise approximately 16% of the Green Area of the SSR, and approximately half of the forested lands in the SSR are actively managed for forestry operations. The forest industry continues to provide jobs for local residents through timber permits, timber quotas, and forest management agreements on public lands. Small timber facilities in the SSR include sawmills, processing facilities, log home manufacturers, and value-added manufacturing plants (Government of Alberta 2017a).

Tourism expenditures in the SSR comprised approximately 34% of the total for Alberta in 2011, with the total income created by tourism estimated at $2.4 billion (Government of Alberta 2017a). The development of recreation infrastructure (e.g., campgrounds) is identified as important for rural areas and small communities to support and retain residents and encourage economic diversification (Government of Alberta 2017a).

Kananaskis Improvement District

The KID is an unincorporated municipality adjacent to the provincial border, south of Canmore and southwest of Calgary. The KID has a total land area of approximately 4,000 square kilometres (km^2) and shares much of its boundaries with Kananaskis Country. Approximately two-thirds of Kananaskis Country is protected as Provincial Parks, Provincial Recreation Areas, Wildland Provincial Parks, and Ecological Reserves, and virtually all land is public land, owned and administered by the Province of Alberta (KID 2015a). Alberta Municipal Affairs is responsible for all functions of local government in the KID, including the administration of business licensing, land use development, finance and taxation, public works, and infrastructure. The secondary focus of the KID is to work with and provide input to the Province of Alberta with respect to land use and resource management (KID 2015a).

Tourism is a key economic driver for the KID. For example, the total number of visitors to the KID was approximately 1,103,000 in 2011, generating expenditures of $194.2 million. These expenditures supported a total (value-added) economic impact of $202.5 million in Alberta in 2011, and sustained approximately 3,023 full-time equivalent (FTE) jobs (Econometric Research 2014). Tourism expenditures generated approximately $117.2 million in total tax revenue to local, provincial, and federal governments in 2011, which included $67.3 million in federal taxes, $35.7 million provincially and $14.2 million to local governments. In addition to recreation and tourism, resource activities in the KID occur on public lands outside of parks, and are key economic drivers for the region, including cattle grazing, timber harvesting, and gas wells (Alberta Parks 2017).

The community of Bragg Creek and the local area Chamber of Commerce undertook an assessment of the local tourism industry following the damage, to natural resources and built infrastructure associated with the 2013 floods.. The report noted that the majority of visitors to Bragg Creek are from Calgary or neighbouring areas, and are traditionally recreation enthusiasts participating in activities such as hiking and mountain biking (Bragg Creek 2015). Other outdoor recreational opportunities and experiences provided in the KID include cross-country skiing, snowshoeing, camping, horse riding, off-highway vehicle use, rafting, fishing, hunting, canoeing, and kayaking. Commercial recreation operators include guide outfitters for hunting, and commercial whitewater rafting. In 2014, the KID authorized 107 Commercial Guiding and Outfitting Permits, representing more than 40 different commercial companies involved in more than 20 different activities (AEP 2016).

Revenue from municipal property taxes comprise the majority of total revenue for the KID. In 2013, actual revenue for the KID was $1,710,933, of which 63.3% was from municipal property tax. The largest category budgeted for regular expenditures from 2013 to 2019 was for fire protection services, followed by garbage services and administration. Due to the 2013 flood, the KID spent $250,786 in flood disaster services in that year (KID 2015b).

Rocky View County

Rocky View County is a municipal district that partially surrounds Calgary and includes the Greater Bragg Creek area. The county does not include Tsuut'ina Nation Indian Reserve No. 145 or the municipalities of Cochrane, Airdrie, Chestermere, Crossfield, Irricana, and Beisecker, all of which, for the purposes of this assessment, are included as part of the Calgary CMA.

Agriculture and related service industries are identified as the primary economic forces in Rocky View County. A main focus of the 2003 Municipal Development Plan was to maintain and encourage a strong and viable agricultural industry while allowing for economic diversification through business and industrial development in appropriate areas such as established hamlets. The county is described as a popular place to live for "country residential living" (Rocky View County 2003). The county has developed Area Structure Plans to direct planning in areas of the county that are experiencing development pressures, including the Greater Bragg Creek area which is located 10 km east of the MC1 area.

The greater Bragg Creek area is bounded on the west by the KID, on the south by the Municipal District of Foothills, and on the east by the Tsuut'ina Nation Indian Reserve No. 145. Extensive agricultural lands owned by the Province lie north of the Municipal District. The greater Bragg Creek area contains the Hamlet of Bragg Creek as well as extensive residential subdivisions in outlying areas and low-density agricultural lands (Rocky View County 2007). The Hamlet of Bragg Creek is located beside the Elbow River, approximately 30 km southwest of Calgary on Highway 22. Bragg Creek is recognized as a gateway community to the parks and recreation areas of Kananaskis Country, and is itself a regional tourism

destination. Bragg Creek has a variety of retail, food, and accommodation services and a strong tourism-based business community. The community hosts numerous cultural and musical events (Bragg Creek and Area Chamber of Commerce 2017).

Townsite of Redwood Meadows

The Townsite of Redwood Meadows is located on the Elbow River northeast of Bragg Creek, on the Tsuut'ina Nation Indian Reserve No. 145. The townsite is leased to Sarcee Developments, which is a wholly owned Tsuut'ina Nation company that leases individual lots to residents. The townsite elects a Mayor and Council, which share administration with the Tsuut'ina Nation Council. Redwood Meadows is a residential community situated around an 18-hole golf course, with no local industry (Calgary Regional Partnership 2012).

Calgary Census Metropolitan Area

Calgary is Alberta's largest urban area, and the economic centre of the province. Economic activity is generated from the energy, financial services, film and television, transportation and logistics, technology, manufacturing, aerospace, health and wellness, retail, and tourism sectors (City of Calgary 2016a). Calgary's GDP in 2015 was approximately $115.2 billion, which represented a decline from 2014 of 3.2% but was still the highest of any Canadian city in 2015 (City of Calgary 2016a). Despite the recent economic downturn, in 2015 Calgary had the highest wages and salaries per employee in Canada, and the highest number of small businesses and head offices per capita (City of Calgary 2016a). Since Calgary's growth is driven by oil and gas investments, lower prices for oil and gas commodities due to oversupply would likely result in a lower rate of investments in oil and gas industries and supply chain industries, which would result in a lower rate of economic growth in Calgary (City of Calgary 2016b).

8.2.2.3 Population and Demographics

The KID registered a population of 221 in 2016, a decrease of 11.2% from its 2011 population of 249 (Statistics Canada 2017). The KID has no official communities since it is designated for recreation and conservation. The 2016 population lived in 58 of the 79 private dwellings in the KID. The small population of the KID is skewed demographically, with only 9.1% of the population aged 0 to 14, and 86.5% aged 15 to 64, compared to 15.2% and 72.6% for the province as a whole, respectively (Statistics Canada 2017). Residences in the KID are located in the resort community of Kananaskis Village (KID administrative centre), Bow Valley Park, Camp Horizon, Kovach, Mount Kidd Recreational Vehicle Park, and the Elbow Ranger Station.

Rocky View County is a municipal district and agricultural region that partially surrounds the Calgary CMA. The population of the county was 39,407 in 2016, an increase of 10.2% from 2011. The median age in Rocky View County is older than Calgary's (i.e., 42.9 versus 36.4), yet the county reported a higher percentage of children (19.4% versus 18.8% in the Calgary CMA).

Within Rocky View County, Bragg Creek recorded a population of 589 in 2016. This total accounted for a minimal (1.0%) decrease in Bragg Creek's population since 2011 (Statistics Canada 2017). The median age of 46.8 is older than the rest of Rocky View County (42.9) and substantially older than the provincial median age of 36.5. In contrast to the rest of Rocky View County, Bragg Creek's population reported a lower percentage of children (15.1% under age 15, versus 18.7% for Alberta). Over 75% of the homes in the community are supported by residents who work in the Calgary area (Rocky View County 2015). Within the community, Banded Peak School provides public education services for grades kindergarten through eight (Rocky View Schools 2017).

The population of Redwood Meadows was reported in a municipal census to be 983 in 2011 (Alberta Municipal Affairs 2017). Demographic information for the townsite itself is not included in municipal population totals by Statistics Canada because the applicable census division includes all of Tsuut'ina Indian Reserve No.145 (Alberta Municipal Affairs 2017). The homes in Redwood Meadows are leased directly from SCD, a Tsuut'ina company. A community census conducted by the townsite in 2014 estimated that more families and fewer seniors lived in Redwood Meadows in comparison to Bragg Creek (Townsite of Redwood Meadows 2016). The townsite consists of 351 single family homes situated around a golf course. The community includes one pre-school but there is no employment base; residents commute to other communities, including those within the Calgary CMA, for employment (Calgary Regional Partnership 2012).

In 2016, the Calgary CMA had a population of 1,392,609, making it Alberta's largest city and Canada's third largest municipality (**Table 8.2-4**). The 2016 population represented a 14.6% increase from its 2011 population of 1,214,839 (Statistics Canada 2017). Calgary's demographics and median age are similar to the province as a whole.

A summary of selected demographic characteristics for the region is provided in **Table 8.2-4**.

Table 8.2-4 Selected Demographic Characteristics, Age Distribution, and Gender Ratio

Jurisdiction	Population (2016)	Population (2011)	Change 2011 to 2016 (%)	Under 15 Years (%)	15 to 64 Years (%)	Median Age
Alberta	4,067,175	3,645,257	11.6	18.7	70.1	36.5
Calgary CMA	1,392,609	1,214,839	14.6	18.8	70.2	36.4
KID	221	249	-11.2	0.0	97.9	29.3
Rocky View County	39,407	36,461	10.2	19.4	69.8	42.9
Bragg Creek	589	595	-1.0	15.1	72.2	46.8

Source: Statistics Canada 2012, 2017
Note: Demographic information for Redwood Meadows is not available.

8.2.2.4 Labour Force Characteristics

Due to its small population, statistical data pertaining to the KID are not available from the 2011 NHS to protect confidentiality. Similarly, NHS data for the community of Bragg Creek are unavailable, although this information is incorporated in the NHS data for Rocky View County. The following information on the regional labour force for Rocky View County is therefore shown to provide a general indication of characteristics in rural areas of the county, including Bragg Creek. Data for the Calgary CMA provide information on the Calgary area and adjacent municipalities, including the Townsite of Redwood Meadows, as part of Tsuut'ina Nation 145 Indian Reserve. Where appropriate, data have also been provided for the Province of Alberta for context.

As noted in **Table 8.2-5**, the combined labour force of Calgary and Rocky View County included 747,400 people aged 15 years and over. Census data from 2011 showed that the overall participation rate in the labour force was similar between Alberta, the City of Calgary, and Rocky View County (ranging from 73.2% to 74.3%) (Statistics Canada 2013). Calgary's unemployment rate in 2011 (5.9%) was consistent with the provincial average (5.8%), while the unemployment rate in Rocky View County was reported to be only 3.7%.

Recent unemployment numbers for the province indicate that the available labour force may be larger than it was in 2011. For example, in March of 2017, the provincial unemployment rate was 8.3%, which represented an improvement from a 22-year high of 9.0% in December 2016. The high provincial unemployment rate was attributed to the economic downturn in Alberta since the decline in oil prices (CBC/Radio-Canada 2017).

Table 8.2-5 Labour Force Characteristics

Area	Total Population Aged 15 Years and Over	In the Labour Force	Employed	Unemployed	Participation Rate (%)	Unemployment Rate (%)
Alberta	2,888,735	2,115,640	1,993,225	122,415	73.2	5.8
Calgary CMA	976,575	725,910	683,190	42,720	74.3	5.9
Rocky View County	29,260	21,490	20,700	790	73.4	3.7

Source: Statistics Canada 2013
Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

Industry

A variety of different industrial sectors drive employment in Calgary and Rocky View County. As shown in **Table 8.2-6**, the highest percentage of workers in Calgary are employed in professional, scientific, and technical services (11.7%), followed by retail trade (10.7%), health care and social assistance (9.3%), and construction (8.7%). A higher percentage of the workforce in Rocky View County is employed in agriculture, forestry, fishing, and hunting (6.9%, versus 0.3% in Calgary). The construction workforce in Rocky View County represents 10.3% of the total workforce, versus 8.5% in the Calgary CMA. Goods-producing industries (e.g., agriculture, forestry, mining, construction, and manufacturing) in the Calgary CMA employ a lower percentage of the workforce than in Rocky View County (i.e., 21.4% versus 29.2%).

Table 8.2-6 Percent Employment by Industry

Industry	Employment (% of total employment by industry)	
	Calgary CMA	Rocky View County
Agriculture, Forestry, Fishing and Hunting	0.6	6.9
Mining, Quarrying and Oil and Gas Extraction	6.3	7.6
Utilities	1.2	1.0
Construction	8.7	10.3
Manufacturing	5.8	4.4
Wholesale Trade	4.4	4.0
Retail trade	10.7	7.4
Transportation and Warehousing	5.6	5.9
Information and Cultural Industries	2.3	1.2
Finance and Insurance	3.8	3.5
Real Estate and Rental and Leasing	2.2	3.3
Professional, Scientific and Technical Services	11.7	12.9
Management of Companies and Enterprises	0.2	0.3
Administrative and Support, Waste Management and Remediation Services	4.0	3.0
Educational Services	6.1	5.8
Health Care and Social Assistance	9.3	7.7
Arts, Entertainment and Recreation	2.2	2.6
Accommodation and Food Services	6.0	3.8
Other Services (except Public Administration)	4.5	4.0
Public Administration	4.3	4.2
All industries (Total number employed)	**725,910**	**21,490**

Source: Statistics Canada 2013
Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

Occupation

As shown in **Table 8.2-7**, occupations in management, business, and finance accounted for in approximately 30% of all occupations in the Calgary CMA and approximately 40% in Rocky View County. Sales and services-related occupations represented the largest percentage of workers by occupation in Calgary (22.2%), compared to only 14.4% in Rocky View County. The percentage of the workforce employed in the trades, transport, and equipment operators was lower in both areas than in Alberta as a whole (Statistics Canada 2013).

Table 8.2-7 Employment by Occupation

Location	Percentage of Total Population Aged 15 and Over by Occupation									
	Management	Business, Finance, and Administration	Natural and Applied Sciences and Related Occupations	Health	Education, Law and Social, Community, and Government Services	Art, Culture, Recreation, and Sport	Sales and Services	Trades, Transport and Equipment Operators, and Related Occupations	Natural Resources, Agriculture, and Related Production Occupations	Occupations in Manufacturing and Utilities
Alberta	11.9	16.7	8.1	6.0	10.2	2.2	21.0	17.6	3.4	3.1
Calgary CMA	11.6	18.9	11.8	5.6	9.9	2.5	21.8	14.0	1.5	2.3
Rocky View County	20.5	18.9	8.9	5.4	9.7	2.3	14.1	15.0	14.2	1.0

Source: Statistics Canada 2013
Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

Income

Income levels and distribution in Calgary and Rocky View County, as presented in **Table 8.2-8**, show variability between rural and urban areas. This information shows that residents of Rocky View County have a higher median and average employment income than residents of Calgary, which is more consistent with the Province overall.

Table 8.2-8 Individual Income Characteristics

Area	Population Aged 15 Years and Over Who Worked Full Year; Full Time with Employment Income in 2010	Median Employment Income in 2010 ($)	Average Employment Income in 2010 ($)
Alberta	1,133,280	55,507	69,438
Calgary CMA	391,155	57,967	77,710
Rocky View County	11,235	63,195	142,893

Source: Statistics Canada 2013
Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

The sources of income for the Socio-Economic Resource VC are demonstrated in **Table 8.2-9**. In 2010, 82.2% of individual market income in Calgary was derived from employment income, which was similar to the provincial average, whereas in Rocky View County this amount was slightly lower (Statistics Canada 2013). Rocky View County recorded a greater amount of individual income from “other” market sources (investment income, retirement pensions; superannuation and annuities, and other money income) in

comparison to the rest of Alberta (i.e., 16.3% compared to the provincial average of 11.4%). Government transfer payments, which include benefits from federal, provincial, territorial, or municipal governments, were important as income in Rocky View County (Statistics Canada 2013).

Table 8.2-9 Source Income

Area	Market Income		Government Transfer Payments (%)
	Employment Income (%)	Other Market Income (%)	
Alberta	81.3	11.4	7.3
Calgary CMA	82.2	12.0	5.8
Rocky View County	78.9	16.3	2.8

Source: Statistics Canada 2013

Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

Educational Attainment

Educational attainment data, representing the highest education level attained for people 15 years and over are presented in **Table 8.2-10**. In Calgary and Rocky View County a higher percentage of the population had obtained a university certificate, diploma, or degree than the provincial average (Statistics Canada 2013). The percentage of people with a trades certification was lower than the provincial average for both areas (Statistics Canada 2013).

Table 8.2-10 Highest Educational Attainment for Percentage of Population Aged 15 Years and Over

Area	Total Population Aged 15 Years and Over by Highest Certificate, Diploma, or Degree (%)	No Certificate, Diploma, or Degree (%)	High School Diploma or Equivalent (%)	Post-secondary Certificate, Diploma, or Degree (%)	Apprenticeship or Trades Certificate or Diploma (%)	College CEGEP or Other Non-university Certificate or Diploma (%)	University Certificate or Diploma below Bachelors Level (%)	University Certificate, Diploma, or Degree at Bachelor Level or Above (%)
Alberta	2,888,735	19.1	26.5	54.5	11.0	18.4	4.2	20.1
Calgary CMA	976,570	15.0	24.7	60.3	8.0	17.4	5.3	29.7
Rocky View County	29,260	13.6	26.6	59.8	9.9	18.3	4.0	27.7

Source: Statistics Canada 2013

Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.
CEGEP - Collège d'enseignement général et professionnel (General and Vocational College)

Population Mobility

The movements of residents in the Calgary CMA and Rocky View County in 2011 indicates residents who are moving residences within the region as well as in-migration from other regions, provinces and countries (Statistics Canada 2013). As shown in **Table 8.2-11**, both the Calgary CMA and Rocky View County have experienced a sharp decrease in the movements of residents. From 2005 to 2010, the percentage of people moving in or out of Calgary dropped by 31%. Similarly, Rocky View County experienced a decrease of 22% in the mobility of its residents (Statistics Canada 2013). The movement of interprovincial and external migrants also declined from 2005 to 2010. For example, in Calgary the movements of total external migrants declined from 71,035 in 2005 to 17,500 in 2011, and the movements of interprovincial migrants declined from 68,770 to 16,755 (Statistics Canada 2013).

Table 8.2-11 Population Mobility of Calgary CMA and Rocky View County Residents

Area	Total - Mobility Status in 2010			Total - Mobility Status in 2005		
	Total	Non-movers %	Movers %	Total	Non-movers %	Movers %
Calgary CMA	1,182,695	84.5	15.5	1,117,990	53.5	46.5
Rocky View County	36,210	90.6	9.4	34,700	68.6	31.4

Source: Statistics Canada 2013

Notes: Rocky View County data includes Greater Bragg Creek area. Redwood Meadows is included in Calgary CMA.

Recent numbers on in-migration from June 2017 report that net migration to Alberta decreased between 2016 and 2017. Net migration to the province totalled 10,292 in the first quarter of 2016, compared to 4,693 in the first quarter of 2017 (Q1 2017). However, the modest in-migration in Q1 2017 still represented the fourth highest level of people migrating into any province, but well behind the 32,787 moving to Ontario, which led net provincial in-migration in this period (Government of Alberta 2017d).

8.2.2.5 Regional Business Profile

MC1 is located in a rural area of the KID, well known for its recreational use; subsequently, the regional economy and business community are largely focused on supporting and servicing the local tourism industry. The population of the KID increases in the summer months due to visitors to parks and recreational areas, and seasonal employees of parks, campgrounds and other tourism-related businesses. Seasonal employment in the KID includes summer positions with campground contractors as maintenance workers, campground store attendants, and campground hosts. Alberta Parks hires seasonal employees for positions such as information officers. Accommodation is typically provided for seasonal employees (Alberta Parks 2017).

As the closest community and business centre to MC1, Bragg Creek accommodates a variety of business types, including small cafes and restaurants, boutiques, artist's galleries, office space, recreation retailers, and a single grocery store. The largest retail category in Bragg Creek is related to food services (28% of total retail space), followed by personal and professional services (23%) and home and furnishings which accounts for 12% of retail space (Rocky View County 2015). In Bragg Creek's 2015 Revitalization Plan, an assessment of commercial demand analysis noted that retail business in the community was reflected by aging strip centres, and high vacancy rates (9.1% overall). In particular, the community's largest retail centre (Bragg Creek Shopping Centre) had a vacancy rate of approximately 20%. The assessment also noted that the overall appearance, tenant mix, and apparent lack of investment of local retail centres suggested low sales or a lack of growth and change in the area. The assessment also noted that the 2013 flood has been a contributing factor in the increase in local commercial vacancies currently experienced throughout the area (Rocky View County 2015).

Additional business and service centres exist in proximity to MC1 and the greater Bragg Creek area. Located approximately 30 km north of Bragg Creek, the community of Cochrane is often used by residents of Bragg Creek for indoor recreation (i.e., swimming) and cultural activities. These trips are also often paired with shopping opportunities, given the presence of the large retail outlets anchored within Cochrane (Rocky View County 2015). Similarly, the accessibility of the urban centre of Calgary, combined with the frequency of work-related trips by residents of the RAA, means that Calgary's extensive retail and services offerings have a large draw on local spending (Rocky View County 2015).

8.2.2.6 Infrastructure and Services

Baseline information on roads, pipelines, oil and gas well sites, power lines, and other infrastructure that could be affected by MC1 is provided in **Section 8.1 Land Use and Management Infrastructure**. A brief overview of the economic aspects of infrastructure and services provision in the RAA, including accommodation, is included in this subsection.

The KID Council manages public infrastructure and services in the KID, in coordination with the Province. As part of its responsibilities, the KID Council establishes a yearly budget and monitors municipal spending to ensure cost effectiveness. The majority of infrastructure in the KID is maintained through private contractors (KID 2015b).

All primary and secondary highways and local roads in the KID, including Highway 66, are maintained by service providers under contract to Alberta Transportation. The KID budgets annually for road maintenance and improvements within the improvement district, and coordinates the required work with Alberta Transportation, reimbursing Alberta Transportation for work completed (KID 2015b).

For 2015 through 2019, the KID council's approved five-year operating budget allowed for yearly expenses of approximately $2.4 million in 2015, increasing to approximately $2.6 million by 2019. As noted in **Table 8.2-12**, yearly budgets for the management of public infrastructure and related services within the KID accounts for more than 50% of its yearly operating costs (KID 2015b).

Table 8.2-12 Kananaskis Improvement District Five-year Operating Budget

Expense	Yearly Budget ($)				
	2015	2016	2017	2018	2019
Fire Protection	$735,100	$749,802	$764,798	$780,094	$795,696
Roads	$125,000	$127,500	$130,050	$132,651	$135,304
Water Supply	$37,500	$38,250	$39,015	$39,795	$40,591
Sewer Supply	$50,000	$51,000	$52,020	$53,060	$54,121
Garbage	$320,000	$326,400	$332,928	$339,587	$346,378
Recycling	$25,000	$25,500	$26,010	$26,530	$27,061
Weed Program	$30,000	$30,600	$31,212	$31,836	$32,472
Total	**$1,322,600**	**$1,349,052**	**$1,376,033**	**$1,403,553**	**$1,431,623**
Total Yearly Operating Costs	**$2,363,100**	**$2,410,362**	**$2,458,569**	**$2,507,741**	**$2,557,895**

Source: KID 2015b

Local infrastructure and services in the RAA lying outside of the jurisdiction of the KID are generally managed by local governments, although some rural areas do not provide official utilities, and private residents are responsible for arranging services with private vendors. For some communities in Rocky View County such as Bragg Creek, the Rocky View County Council and administration manage much of the public infrastructure and related services including water, wastewater, garbage pickup, road maintenance, fire protection, and waste management. In Bragg Creek, Rocky View County also provides water and wastewater utility services. (Rocky View County 2007).

In Calgary, infrastructure and services including utilities are administered through the City's Environment department (City of Calgary 2017).

Accommodation

A variety of housing and accommodation is provided within the RAA, although rural areas such as Bragg Creek and other communities in Rocky View County have a much narrower range of housing types than in Calgary. Whereas Calgary provides a larger variety of single-detached and multi-family housing, communities such as Bragg Creek traditionally restrict higher-density housing, with the majority of available housing being predominantly single-family, detached housing (Rollo and Associates 2015). As reported in the 2011 Census, a total of 286 private dwellings were reported in Bragg Creek, of which 227 were single-detached houses and 5 were row houses, with 0 apartments (Statistics Canada 2012).

According to the 2011 Census data, 92.2% of dwellings in Rocky View Country are occupied by the owner, with 7.8% occupied by renters. Such a high percentage of owner occupancy is in sharp contrast to the Calgary CMA, which recorded 73.9% of its occupied dwellings as owner-occupied. Also noted in **Table 8.2-13**, the average median costs for both owner- and renter-occupied dwellings are consistent throughout the RAA, with less than a 10% variance between the Calgary CMA and Rocky View County.

Table 8.2-13 Housing Characteristics of the Regional Assessment Area

	Rocky View County			Calgary CMA		
	Number	% of Total	Median Monthly Payment ($)	Number	% of Total	Median Monthly Payment ($)
Total Private Dwellings	12,185	--	$1,440	464,000	--	$1,355
Occupied by Owner	11,235	92.2	$1,470	342,855	73.9	$1,393
Occupied by Renter	955	7.8	$1,087	120,950	26.1	$1,097

Source: Statistics Canada 2013

Further review of shelter-to-income data from 2011 identified that approximately 19% of households in Rocky View County and 20% of residents of the Calgary CMA were spending 30% or more of their total income on housing costs in 2012 (Statistics Canada 2013).

Statistical data on the vacancy rates of rental properties in Rocky View County, and specifically the community of Bragg Creek were not identified in review of publicly available sources. Data presented by the Canada Mortgage and Housing Corporation shows that the Calgary CMA experienced fluctuations of up to 4% in rental vacancy rates between 2010 and 2015 (**Table 8.2-14**). Rental availability in the Calgary CMA is also consistently lower than that of the Province overall, indicating an increased demand for rental housing typically found in urban areas.

Table 8.2-14 Rental Vacancy Rates in the Calgary Census Metropolitan Area

Area	2010	2011	2012	2013	2014	2015
Alberta	4.6	3.4	2.0	1.6	2.1	5.7
Calgary CMA	3.6	1.9	1.3	1.0	1.4	5.3

Source: CMHC 2016

8.2.3 APPLICATION CASE

The Application Case describes the potential MC1-related effects on Socio-economic Resources, which are added to the Baseline Case. The following sections present the potential interactions and a description of potential effects and mitigation measures, along with an assessment of residual effects.

8.2.3.1 Potential Option Interactions

Physical works, including activities required for construction, operation, and maintenance of MC1 components could interact with the Socio-economic Resources VC. MC1-related interactions with the Socio-economic Resources VC would include all construction activities that require a labour component (**Table 8.2-15)**. The Operation and Maintenance phase of MC1 could interact with the provincial and regional economy.

Table 8.2-15 Potential Interactions with Socio-economic Resources Valued Component

Phase	Activity	Socio-economics	
		Interaction	Potential Effect
Construction	Clearing	X	Change in provincial and regional economies Change in labour force Change in contracting and procurement opportunities Change in economic activities of resource-dependent businesses and industry Change to regional economic conditions Change in availability of accommodation Change in infrastructure and services
	Road construction	X	
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	
	Dam (cofferdam and earth fill) construction	X	
	Spillway construction	X	
	Rock groin and diversion tunnel construction	X	
	Laydown areas construction and use	X	
	Stockpile development and use	X	
	Borrow and spoil areas development and use	X	
	Realignment of McLean Creek and other small waterbodies	X	
	Realignment of Highway 66	X	
	Storage of water in permanent pond	X	
	Reclamation	X	
Operation and Maintenance	Routine and flood operations and maintenance	X	Change in provincial and regional economies

Note: X – potential interaction

The following subsections describe potential interactions with the Socio-economic Resources VC (listed in **Table 8.2-15**), identify potential mitigation measures and their implementation (**Section 8.2.3.3**), and discuss residual effects (**Section 8.2.3.4**).

Potential MC1-related effects from changes in land and resource use are addressed in **Section 8.1 Land Use and Management Infrastructure**. An assessment of the reduced risk to life provided by flood mitigation is provided in **Section 8.3 Public Health and Safety**.

8.2.3.2 Potential Socio-economic Effects

This section presents the consideration of potential adverse MC1-related effects on the Socio-Economic Resource VC arising from potential interactions, as identified in **Table 8.2-14,** and in relation to the measurable parameters listed in **Table 8.2-2**. Mitigation measures for each potential effect are described in **Section 8.2.3.3.** Potential MC1-related effects on Socio-economic Resources are described below.

Change in Provincial and Regional Economies

MC1 capital expenditures (CAPEX) and operating expenditures (OPEX) would generate economic effects on the provincial and regional economies during the Construction and Operation and Maintenance phases, as measured by contributions to gross output, GDP, labour income, and employment as defined below.

- Gross output is defined as the total value of goods and services produced in the economy to meet MC1 requirements.
- GDP is defined as the value added to the economy as a result of MC1, and is a key economic measure of MC1-related economic effects.
- Labour income is derived from the total earnings of employees, including supplementary earnings such as pension plan contributions and worker's compensation funds.
- Employment is a key measure of MC1's contribution to the regional economy. This measure is described in more detail in the following subsection, Change in Labour Force.

A cost estimate provided by Opus Stewart Weir was used to estimate the economic effects of MC1. The cost estimate used for the Input-Output model and analysis is summarized in **Table 8.2-16**. The summary information presented is rounded to the nearest $1,000.

Table 8.2-16 Capital Cost Estimates

Components	Materials/Activities	CAPEX ($)	**Contingencies (CAPEX * 20%)**	**Total Cost ($)**
Engineering Design, Environmental, Engagement	Subtotal	52,904,000	10,580,800	**63,485,000**
Mobilization, Care of Water, Wetland Compensation and Aquatic Habitat Management	Subtotal	24,108,000	4,822,000	**28,930,000**
Main Dam	Instrumentation	700,000	140,000	840,000
	Construction	100,162,000	20,032,000	120,194,000
	Subtotal	100,862,000	20,172,000	**121,034,000**
Diversion Tunnels	Subtotal	36,577,000	7,315,000	**43,892,000**
Spillways	Subtotal	45,778,000	9,156,000	**54,933,000**
Highway 66 Relocation	Traffic Services	394,000	79,000	473,000
	Construction	13,070,000	2,614,000	15,684,000
	Subtotal	13,464,000	2,693,000	**16,157,000**

Components	Materials/Activities	CAPEX ($)	Contingencies (CAPEX * 20%)	Total Cost ($)
Highway 66 Bridge	Steel Superstructure	8,400,000	1,680,000	10,080,000
	Construction	12,476,000	2,495,000	14,971,000
	Subtotal	20,876,000	4,175,000	**25,051,000**
Facility Relocation	Construction activities (e.g., clearing, grubbing, excavation)	1,548,000	310,000	1,858,000
	Buildings	9,428,000	1,886,000	11,314,000
	Water and wastewater treatment	3,377,000	675,000	4,052,000
	McLean Creek Campground and store	2,205,000	441,000	2,646,000
	Miscellaneous demolition/salvage (e.g., fueling station, helipad, line removal, weather station, site restoration)	4,800,000	960,000	5,760,000
	Miscellaneous new construction (e.g., fueling station, fencing, recreation amenities)	515,000	103,000	618,000
	Powerlines, propane, communications	980,000	196,000	1,176,000
	Subtotal	22,853,000	4,571,000	27,424,000
TOTAL Dam, Highway Relocation and Facility Relocation		317,422,000	63,484,000	**380,907,000**

Note: Cost estimate is subject to change as MC1 design is refined.

The total rounded cost of CAPEX for dam construction, highway relocation, and facility relocation is estimated in **Table 8.2-16** to be $380,907,000, including a 20% contingency. OPEX was assumed to equal 1% of CAPEX in net present value, which equals $81 million over a 50-year operating period. It is recognized that CAPEX is subject to change in the event that MC1 design details are refined; however, incremental changes to the cost estimate used in this analysis are not considered to materially affect the conclusions herein. The Input-Output model uses CAPEX, OPEX and Alberta economic multipliers (2011) to provide estimates of direct, indirect, and induced effects of MC1 Option expenditures on gross provincial output, GDP, labour income, and employment during MC1 construction and operation and maintenance (refer to definitions presented earlier in this section and **Table 8.2-17** below). Effects on employment are discussed in the following subsection, **Change in Labour Force**.

Table 8.2-17 Economic Effects of MC1 Capital Expenditures

Effect	Gross Output ($)	Gross Domestic Product ($)	Labour Income ($)	Employment (FTE Jobs)
Direct and Indirect Effects	469,490,000	238,226,000	162,040,000	2,700
Induced Effects	96,325,000	66,736,000	33,111,000	2,000
TOTAL Effects (Present Value)	**546,958,607**	**281,372,082**	**180,055,362**	**4,300**

Notes: Direct Impact – Impacts generated directly by MC1.

Indirect Impact – Impacts of goods and services indirectly generated by MC1, such as inter-industry purchases.

Induced Impact – Impacts of goods and services produced in response to spending generated by wages generated (directly or indirectly) by MC1.

Gross Output – total value of goods and services produced in the economy to meet Option requirements.

GDP – value added to the economy as a result of MC1.

Labour income – total earnings of employees.

FTE jobs – One FTE is equivalent to 12 months of employment, but not necessarily the same worker.

The economic analysis of the effects of Option operation and maintenance is summarized in **Table 8.2-18**. The present value reported in **Table 8.2-18** represents the current worth of economic effects given the specific rate of return. The present value of OPEX effects is discounted over 50 years, using a discount rate (i.e., rate of return) of 3.3%. MC1 is assumed to be operational for 50 years for the purpose of estimating economic effects.

Table 8.2-18 Economic Effects of MC1 Operating Expenditures

Effect	Gross Output ($)	Gross Domestic Product ($)	Labour Income ($)	Employment (FTE Jobs)
Direct and Indirect Effects	5,682,000	2,536,000	1,713,600	28
Induced Effects	982,000	712,000	365,400	21
TOTAL Effects per Year	6,664,000	3,248,000	2,079,000	49
Present Value of Effects	166,961,000	81,376,000	52,088,000	1,240

Notes: Refer to Table 8.2-17 for definitions.

Present value of impacts is discounted over 30 years, using a discount rate of 3.3%. Present value represents the current worth of economic impacts given the specific rate of return.

The key economic metric of the Input-Output model is GDP, since GDP represents the net economic activity that would be generated in Alberta by MC1 construction, and operation and maintenance. These results are solely an assessment of the economic impact in Alberta of MC1's CAPEX and OPEX (i.e., the purchase of goods and services to build and operate MC1).

The economic analysis assumed a 50-year Operation and Maintenance phase. Combined CAPEX and OPEX are estimated to equal $462 million over a 50-year Operation and Maintenance period, in present

value. Since current estimates of flood damage reduction are being developed concurrently for MC1, the economic analysis used a previous estimate of the benefits of flood damage reduction, which was a minimum of $336 million in present value (IBI Group 2015). The total GDP in present value is estimated to be $362,748,000; thus, the increase in the sum of provincial GDP and minimum flood damage reduction (approximately $699 million) is higher than the sum of CAPEX and OPEX ($462 million), indicating that MC1 would have a net positive economic effect. The basic benefit-to-cost ratio ($699 million / $462 million) is 1.5, indicating that benefits would outweigh costs. This calculation does not account for economic effects related to loss of resource uses, loss of recreational use of lands affected by MC1 or costs that may be associated with land acquisition, and is provided in this assessment only as an indication of the direction of the residual effect.

MC1 would also contribute to provincial tax revenues, including income taxes paid by workers who are directly or indirectly employed by MC1, and corporate income taxes from contractors and suppliers. Tax revenues may also be generated by net sales on goods and services.

The net positive economic effect indicated by the results of the Input-Output model and minimum flood damage reduction represents a positive change to provincial and regional economies and a potential positive effect.

Change in Labour Force

Construction activities would begin with site preparation, construction of access roads, the construction camp at McLean Creek campground, and borrow pits. The construction schedule identifies activities expected to start during the first year of construction, including excavation and construction of the diversion tunnels, access roads, highway relocation and bridge construction, and relocation of facilities including the Elbow Valley Ranger Station and campground. Relocation of Highway 66 would begin at the start of the Construction phase and would be completed in approximately two years. Bridge relocation would take approximately 1.5 years to complete. Initial works and tunneling would be completed in approximately one year, with construction of the spillways continuing into the third year of construction. Construction of the main dam components would also continue into the third year of construction. Peak workforce numbers would be required during simultaneous construction of multiple components, such as the tunnels, dam components, spillways, and highway and facility relocation. Construction activities would take place 24 hours per day, 7 days per week using rotational shift work.

Alberta Transportation estimates that the active workforce for the Construction phase would likely range between 100 to 150, increasing to approximately 200 at peak construction periods. According to the results of the Input-Output analysis, the total direct and indirect employment generated by the Construction phase is estimated to be 2,700, measured as FTE employment (**Table 8.2-17**). This estimate accounts for FTE of

workers directly engaged in the Construction phase, as well as those hired by contractors and suppliers for MC1.

Each FTE represents 12 months of full-time employment, not necessarily by the same worker. The information regarding direct and indirect effects on employment in **Table 8.2-17** represents an estimate of FTE jobs that would be directly required for MC1 construction, as well as indirect jobs such as increased hiring by contractors and suppliers of MC1. The information regarding induced effects on employment in this table represents an estimate of jobs that may be created in other industries, stimulated by the positive economic effects of MC1 on the regional and provincial economies. Induced employment during construction refers to the increase in supply-line employment and in other industries that hire more workers as a result of the economic stimulus provided by MC1.

Anticipated employment for MC1 Operation and Maintenance phase is minimal, since there is no requirement for daily management of the gates (**Table 8.2-18**). Operation and Maintenance-phase work would consist of periodic inspections to manage the risk of debris and bank erosion, as well as security requirements and general maintenance activities.

MC1 would require workers with trades or professional skills and occupational training for dam construction, as well as unskilled labourers. The change in the regional labour force exerted by MC1 would partly depend on the number of workers who could be sourced from the RAA. Although some workers, including those with special skills, may be sourced from outside the RAA, most would likely be primarily sourced from the RAA and specifically from the Calgary area. While local or regional contractors supplying MC1 would likely hire labour from nearby communities for both skilled and unskilled positions, the regional workforce may lack the capacity to adequately supply MC1. This temporary reduction in available workforce could occur if other projects or industries in the region are already providing full employment, or if the availability of workers is typically low in the region. If other large construction projects in the RAA have similar schedules or workforce requirements, MC1 may affect the availability of the labour pool for other projects.

Prior to construction, design and planning requires engineering, project management, and other professional and technical expertise. Activities during pre-construction would include vegetation clearing, logging, and other site preparation activities that would require workers such as heavy equipment operators, fallers, and general labourers (i.e., unskilled workers). Construction would require the largest workforce for MC1 to construct the dam, spillway, rock groin, and diversion tunnels.

The change to the labour force resulting from MC1 would also depend on factors such as the overall size of the regional construction labour force, and the unemployment rate. In the Calgary CMA, the participation rate (i.e., those actively in the labour force) was 74.3%, and the unemployment rate was 5.9% in 2011 (Statistics Canada 2013). Occupations related to trades and construction are considered most likely to be a match for construction workforce requirements. Workers employed in the construction industry made up

8.7% (62,228) of total workers in the Calgary CMA in 2011, and 14.0% of workers are employed in trades, or as transport and equipment operators and other related occupations. These statistics suggest that an adequate labour pool would be available in the Calgary CMA and other areas of the province for MC1-related construction jobs.

MC1-related potential change to the labour force during the Construction phase constitutes a potential positive effect. The effect would likely be negligible for the Operation and Maintenance phase. Based on available information, there would likely be no adverse effect on the labour force, since the large labour pool in the Calgary CMA and the rest of the RAA would likely support the employment requirements for MC1.

Change in Contracting and Procurement Opportunities

During the Construction phase, contracting opportunities are likely to be available for clearing and site preparation, tree removal, surveying, material and equipment transport, equipment rental, provision of goods and services, and other construction requirements. Additional contracting opportunities include a self-contained, on-site work camp that is proposed for the duration of MC1 construction, which would likely have a capacity for 100 workers.

It is assumed that construction contracts would be based on a competitive bidding process with tenders open to the public. It is also assumed that contracting opportunities would not target local businesses, but would likely be of a large enough scale to benefit local businesses through indirect and induced economic effects. During the Operation and Maintenance phase, contract opportunities for general maintenance activities are likely to be administered by Alberta Environment and Parks. The majority of MC1 activities would take place during construction; therefore, most contracting opportunities for local and regional companies would likely be available during the Construction phase.

The anticipated increase in contracting and procurement opportunities for regional businesses is considered as a positive potential effect of MC1.

Change in Economic Activities of Resource-dependent Businesses and Industry

MC1 would result in the inundation of public land for the permanent pond, and would disturb current resource uses of lands in MC1 area, including forest harvesting activities, cattle grazing on grazing allotments, and sand and gravel extraction. Additionally, during MC1 Construction phase, high-intensity recreational use of the Elbow Valley would be displaced, and would require closure and relocation of McLean Creek and River Cove campgrounds. MC1 construction is also likely to disrupt use of Camp Horizon and commercial uses in other adjacent disposition areas due to noise, dust, and air emissions. Details on effects to land use are provided in **Section 8.1 Land Use and Management Infrastructure**.

The expected economic effects due to loss of campground fees from displaced campgrounds is provided in **Table 8.2-19**. MC1 would remove access to these campsites during the Construction phase. No data were available to characterize occupancy rates at these campsites, although available information from 2012 reported that campground use in the Elbow River valley was approaching high occupancy in the summer months (Government of Alberta 2012). Rates of occupancy are conservatively assumed to be 80% for May 1 to September 30, and 30% for October 1 to April 30 in year-round campsites. Depending on the length of the Construction phase, a three-year closure would entail a revenue loss of approximately $5.5 million, and a four-year closure would entail a revenue loss of close to $7.3 million, less the savings in campsite operations and ownership. No data are available on cost savings associated with campground closure; therefore, an assumption was made that cost savings would be 75% of revenue. Based on this assumption, net costs of the closure in net present value would be approximately $1.4 million over three years and $1.7 million over four years.

Table 8.2-19 Campgrounds Potentially Affected by Construction of MC1 Option

Campground	Total # of Sites	Site Types	Season	Cost per site/per night (Basic / serviced site)
McLean Creek	170	74 basic 96 serviced	Year round	$26/$33
Paddy's Flat	98	98 basic	May-Sept	$26
River Cove	15-20 (group site)	15-20 group sites	Year round	$31
Gooseberry	85	28 basic 51 serviced 6 walk-in	Year round	$26 $33 $26
Total Sites	Approximately 373	-	-	-

Source: Government of Alberta 2017e, f, g, h

The change in economic activities to resource dependent businesses and industry, including campground operators, resource users, and commercial operators, is considered a potential adverse effect of MC1. For this assessment, the potential adverse effect is assumed to occur during the Construction phase.

Change to Regional Economic Conditions

Changes to local and regional spending primarily refers to the construction workforce spending earnings on goods and services, thereby redistributing employment income in the region and contributing to induced employment and GDP. A portion of the induced GDP and employment can be attributable to construction workers purchasing gas, groceries, meals, and other goods and services from businesses in nearby communities. Bragg Creek, located 10 km from MC1, is the community most likely to experience increased spending at local businesses. Workers commuting daily to MC1 from Calgary and other communities would likely purchase goods and services in Bragg Creek. Workers living at the on-site work camp may choose

to purchase meals and spend leisure time in Bragg Creek. The potential change to regional economic conditions resulting from increased spending by MC1 workforce is characterized as a positive effect.

Change in Availability of Accommodation

MC1 is approximately a 60-minute drive (58 km) from Calgary along Highway 66. The majority of workers coming from the RAA are considered likely to commute from the Calgary area. Workers may also choose to live in the proposed work camp, which has a capacity of 100. Peak construction periods may require 200 workers.

Some workers may elect to rent or purchase homes in Bragg Creek or Redwood Meadows, rather than commute or live in the work camp. Accommodation in Bragg Creek (approximately 10 km east of MC1) and Redwood Meadows (approximately 20 km east of MC1) consists of detached, single-family homes that are owner occupied, and the availability of temporary accommodation in Bragg Creek is likely to be low. Workers who choose to move to local communities during construction may affect the availability of housing for other prospective residents. Workers may also choose to live in recreational vehicles in available campsites near MC1, which could further reduce campsite availability during construction. The demand for short-term and temporary accommodation in the region due to MC1 construction may have an adverse effect on availability of accommodation for others in the region (e.g., visitors and residents).

No detectable increase in the workforce population during the Operation and Maintenance phase is likely due to MC1; therefore, no detectable increase in demand on accommodation is expected during MC1 Operation and Maintenance phase.

Change in Infrastructure and Services

The population influx to local communities from Construction-phase workers may result in increased demand for community services, such as health care and recreational facilities. The majority of construction workers are considered likely to commute from Calgary or other areas of the RAA, or stay in the work camp. Emergencies that may occur during MC1 Construction or Operation and Maintenance phases may be treated on-site, or would require local or regional health care facilities. Local services currently support the needs of visitors, and would likely have adequate capacity to accommodate a short term, incremental, increase in users. Infrastructure and service requirements would not be anticipated to noticeably increase as a result of MC1, but demands would be similar to those currently experienced in the region due to current tourism levels and the non-permanent population. This effect is considered to be negligible and is not further assessed.

8.2.3.3 Mitigation Measures

Mitigation measures comprise any practical means taken to manage potential adverse effects, and may include applicable standards, guidelines, and best management practices supported by specific guidance

documents. Mitigation measures to address potential adverse effects, discussed in **Section 8.2.3.2,** are described below and summarized in **Table 8.2-20**. The final column in the table identifies whether or not there is the potential for a residual effect. In accordance with Alberta Transportation standard practice, best management practices and standard mitigation measures would be included in the Environmental Construction Operations Plan (ECO Plan) Framework that would be developed by the contractor and reviewed by Alberta Transportation prior to the start of construction.

The selection of mitigation measures was informed by a review of mitigation measures and follow-up programs, including mitigation undertaken for past projects and mitigation proposed for an earlier design of MC1 (AMEC 2015). Mitigation measures are provided below for identified potential effects. No specific enhancement measures are proposed to address positive socio-economic effects.

Mitigation for Loss of Economic Opportunity

Mitigation measures to address the estimated loss of economic opportunity related to resource use, commercial use, and campground operations would likely fully mitigate the potential change in economic activities of resource-dependent businesses and industry. Mitigation measures intended to address potential effects on land use and management may also partially mitigate this effect, including:

- Identify alternative areas to offset loss of protected areas
- Retain or reconstruct access to affected recreation areas, where feasible
- Communicate MC1 construction schedule and road closure schedules
- Consult with disposition holders
- Develop and implement Traffic Accommodation Strategy
- Compensate grazing allotment holders.

Refer to **Section 8.1 Land Use and Management Infrastructure** for further detail on the above mitigation measures.

Establishment of a Work Camp during Construction

The mitigation measure is intended to address a potential change in the availability of accommodation. A temporary, self-contained work camp with all services (i.e., water, wastewater, power, and natural gas) would be used by construction workers for the duration of the Construction phase. The on-site camp would be located west of the current campground at McLean Creek. The capacity of the work camp is expected to be approximately 100 for an average construction workforce. The peak construction workforce is expected to be 200, such as during the summer months of each year and during portions of Year 1 and Year 2 when multiple MC1 components are likely to be constructed simultaneously according to the current construction schedule (May 2017).

Additional accommodation would be required for peak workforce periods. Workers may travel the estimated 50-minute commute from Calgary, or may find accommodation in Bragg Creek, Redwood Meadows, or in Elbow River valley campgrounds. Local communities, including Bragg Creek and Redwood Meadows, are likely to have minimal available accommodation, since these communities largely consist of detached, single-family homes that are mostly owner-occupied. Some workers may choose to purchase or rent homes in these communities, if available, and some may choose to stay in campgrounds or other temporary accommodation in the RAA for short periods. As such, the proposed mitigation partially mitigates the change in the availability of accommodation.

Table 8.2-20 Summary of Potential Effects and Mitigation Measures for Socio-economic Resources

Summary of Potential Effect	Option Phase	Contributing Option Activities	Proposed Enhancement or Mitigation Measure	Detectable / Measurable Residual Effect
Change in provincial and regional economies	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage	The effect would be positive and no enhancement measures are proposed.	Yes
Change in labour force	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage	The effect would be positive and no enhancement measures are proposed.	Yes
Change in contracting and procurement opportunities	Construction Operation and Maintenance	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	The effect would be positive and no specific enhancement measures are proposed.	Yes
Change in economic activities of resource-dependent businesses and industry	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage	Mitigation for loss of economic opportunity. Mitigation in Section 8.1 Land Use and Management Infrastructure.	Yes
Change to regional economic conditions	Construction Operation and Maintenance	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage; routine and flood operations and maintenance	The effect would be positive and no specific enhancement measures are proposed.	Yes

Summary of Potential Effect	Option Phase	Contributing Option Activities	Proposed Enhancement or Mitigation Measure	Detectable / Measurable Residual Effect
Change in availability of accommodation	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage	Temporary work camp during the Construction phase.	Yes
Change in infrastructure and services	Construction	Clearing; road construction; Option component construction; use of borrow, spoil, and laydown areas; realignment of utilities; permanent storage	The effect would be negligible and no mitigation is proposed.	No

8.2.3.4 Residual Effects

Residual effects are MC1-related effects that are anticipated to occur to VCs after the application of mitigation measures. This section describes how the residual effects of MC1 are characterized and summarized for the Socio-economic Resources VC. An overview of post-mitigation (residual) effects is provided in **Table 8.2-17**. Residual effects are characterized based on the criteria defined in **Table 8.2-21**.

Potential MC1-related residual effects are delineated as:

- Non-substantive residual effect – mitigation measures have not fully eliminated the effects, but have reduced the magnitude, extent, or duration to such a degree as to avoid a substantive effect on the VC. This characterization is based on the definitions and rating of effects characteristics outlined in **Table 8.2-21**.
- Substantive residual effect – adverse effects are predicted to be high in magnitude or long-term in duration even after implementation of mitigation.

Table 8.2-21 Residual Effects Characteristics for Socio-economic Resources

Residual Effect Characteristic	Rating	Definition
Direction	Positive	The trend of the effect is considered desirable or an improvement from baseline conditions.
	Adverse	The trend of the effect is considered undesirable or worsening from baseline conditions.
Extent	Local	Limited to an effect-specific local area
	Regional	Limited to the RAA
Magnitude	Negligible	No detectable change to Socio-economic Resources VC from baseline conditions
	Minor	Change in the Socio-economic Resources VC is detectable; however, effect is limited to an inconvenience or nuisance change.

Residual Effect Characteristic	Rating	Definition
	Moderate	Change is detectable and results in a moderate change to socio-economic indicator.
	Major	Change in the Socio-economic Resources VC is large enough to result in a severe change to the change to socio-economic indicator.
Duration	Short-term	Effect occurs during Construction phase.
	Long-term	Effect extends through the Operation and Maintenance phase.
Reversibility	Reversible	Effect is reversed once the activity causing the residual effect ceases.
	Not reversible	Effect is permanent.
Frequency	Isolated	Effect occurs once.
	Periodic	Effect occurs intermittently and repeatedly.
	Continuous	Effect occurs continuously.
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to MC1 area.
	Moderate	Rating predictions are based on a good understanding of cause-effect relationships relying on data from elsewhere, or incomplete understanding of cause-effect relationships from data specific to MC1.
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data.

Increase to Provincial and Regional Economies

The increase to the regional economy and to a lesser extent, the provincial economy would be positive and substantive, with moderate magnitude and over the long-term. The change would be an increase in GDP, labour income, and employment. Even if induced effects on economic conditions are not included, CAPEX would generate direct and indirect effects of $238,226,000 in GDP, $162,040,00 in labour income, and 2,700 jobs (FTE) during construction. MC1 would result in a moderate contribution to GDP which would likely have a detectable effect on the regional economy. The majority of economic effects to regional and provincial economics would likely occur during construction; minor economic benefits would persist through the Operation and Maintenance phase. Confidence in these rating predictions is moderate. The economic effects of infrastructure projects are generally well-understood and predictable; however, land acquisition costs, updated flood damage reduction benefits, and the economic effects of loss of resource and recreational use are not yet known and are recognized as sources of moderate uncertainty. The effect characteristics ratings are summarized below in **Table 8.2-22**.

Table 8.2-22 Summary of Effect Characteristics Ratings for Increases to Provincial and Regional Economies

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Positive	The economic benefits of MC1 would outweigh the costs.
Extent	Regional	Expenditures would affect the regional economy, with a smaller effect expected on the provincial economy.
Magnitude	Moderate	MC1 would result in a moderate contribution to provincial GDP which would likely have a detectable effect on the regional economy.
Duration	Long-term	The majority of economic effects to regional and provincial economics would likely occur during the Construction phase. Minor economic benefits would persist through the Operation and Maintenance phase.
Reversibility	Reversible	The majority of economic benefits would cease once MC1 is commissioned.
Frequency	Continuous	Economic benefits would accrue as a result of construction and on an ongoing basis throughout the Operation and Maintenance phase.
Confidence	Moderate	The economic effects of major infrastructure projects are generally well-understood. However, details of land acquisition costs, updated flood damage reduction benefits, and loss of resource and recreational use are not yet known.

Change in Labour Force

The change the labour force is considered to be a positive, but non-substantive residual effect, and is likely to be of moderate magnitude, in consideration of the available labour pool of workers in the construction industry or other goods-producing industries in the Calgary CMA. MC1 would require a construction workforce of 100 to 150 workers, increasing to 200 at peak construction periods. The total direct and indirect employment generated by the Construction phase is estimated to be 2,700, measured as FTE employment (**Table 8.2-17**). The change in employment for the Operation and Maintenance phase is shown to be negligible (**Table 8.2-18**). The effect would likely be regional, with much of the labour required for MC1 sourced from the Calgary CMA and adjacent areas of the RAA. Since changes to the labour force are likely to be imperceptible during the Operation and Maintenance phase, the effect would be reversible. The influence of large infrastructure projects on the labour force is generally well understood; thus, confidence in the assessment of the effect is high. The effect characteristics ratings are summarized below in **Table 8.2-23**.

Table 8.2-23 Summary of Effect Characteristics Ratings for Change in Labour Force

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Positive	The change to the labour force is considered positive in direction.
Extent	Regional	Effects would extend to the regional labour force, particularly in the Calgary CMA.
Magnitude	Moderate	The change to the labour force resulting from Option employment constitutes a moderate modification to the human environment
Duration	Short-term	Option employment is largely confined to Construction activities.
Reversibility	Reversible	Construction employment would cease once MC1 is commissioned.
Frequency	Continuous	The effects on the labour force would persist through Construction.
Confidence	High	MC1-related effect on the labour force is well understood and predictable.

Change in Contracting and Procurement Opportunities

The change in contracting and procurement opportunities would be a non-substantive, positive effect of moderate magnitude. The duration would be short-term because the scale of MC1 is assumed to generate the majority of opportunities for contractors during the Construction phase. The extent of the effect would be regional, as potential contractors would be situated throughout the RAA. Confidence in the rating predictions is high, since MC1 would provide opportunities for contracting and procurement during construction and, to a lesser extent, during the Operation and Maintenance phase. The effect characteristics ratings are summarized below in **Table 8.2-24**.

Table 8.2-24 Summary of Effect Characteristics Ratings for Change in Contracting and Procurement Opportunities

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Positive	The effect would be an increase in contracting opportunities.
Extent	Regional	The effect applies to businesses in the RAA.
Magnitude	Moderate	The scale of MC1 would likely generate substantial opportunities for contractors during the Construction and Operation and Maintenance phases.
Duration	Short-term	Contracting opportunities would mainly apply to Construction phase.
Reversibility	Reversible	
Frequency	Continuous	The effect would persist through Construction and Operation and Maintenance phases.
Confidence	High	MC1-related effect on the contracting opportunities is well-understood and predictable.

Change in Economic Activities of Resource-dependent Businesses and Industry

The change in economic activities of resource-dependent businesses and industry is an adverse, non-substantive effect of minor magnitude, after mitigation (i.e., compensation) is applied. Although the effect would be primarily on lands and uses displaced by MC1, economic loss may be experienced by campground operators and resource interests based in other areas of the RAA. The effect constitutes an inconvenience after mitigation, consisting of geographical or logistical changes to resource, commercial, or campground operations. The confidence in the effect assessment is considered to be moderate. There is a solid understanding of how lost economic opportunity can be appropriately compensated, but the full extent of economic loss is unknown for grazing and forestry activities as well as profits associated with McLean Creek store and other commercial uses affected by MC1. Refer to **Section 8.1 Land Use and Management Infrastructure** for a description of the dispositions affected by MC1. The effect characteristics ratings are summarized below in **Table 8.2-25**.

Table 8.2-25 Summary of Effect Characteristics Ratings for Change in Economic Activities of Resource-dependent Businesses and Industry

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	The lost economic opportunity due to MC1 is an adverse effect.
Extent	Regional	Although the physical effect would be primarily on lands and uses displaced by MC1, economic loss may be experienced by campground operators and resource interests based in other areas of the RAA.
Magnitude	Minor	The effect constitutes an inconvenience after mitigation, consisting of geographical or logistical changes to resource, commercial, or campground operations.
Duration	Short-term	Compensation would likely mitigate the economic effect, and relocated campgrounds and other facilities and infrastructure would likely be in place after construction.
Reversibility	Reversible	Replacement recreational areas (and, as appropriate, compensation) would reverse the effect.
Frequency	Isolated	Economic loss is associated with the displacement or disruption of recreational, commercial, and resource areas.
Confidence	Moderate	There is a good understanding of how MC1 would cause lost economic opportunity, but the full extent of economic loss is incomplete due to unknown extent of grazing and forestry activities, economic loss associated with McLean Creek store, and the value of other commercial uses affected by MC1.

Change to Regional Economic Conditions

The potential positive effect to regional economic conditions is likely to be non-substantive and moderate in magnitude, due to the expected induced effects caused by MC1 during construction. Effects from construction of MC1 would result in changes to regional businesses from the construction workforce spending earnings on goods and services, thereby redistributing employment income in the region and contributing to induced employment and GDP. The effect would be regional in extent, with the potential for increased spending inducing an increase in GDP and employment throughout the RAA. Confidence in the rating predictions is high because there is a good understanding of how MC1 may create induced economic effects on regional businesses. The effect characteristics ratings are summarized below in **Table 8.2-26**.

Table 8.2-26 Summary of Effect Characteristics Ratings for Change to Regional Economic Conditions

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Positive	The change to regional economic conditions due to MC1 is a positive effect, due to increased local spending.
Extent	Regional	The effect would likely be detectable in nearby communities and businesses in the RAA.
Magnitude	Moderate	The scale of MC1 indicates a moderate effect from increased spending and associated induced economic effects.
Duration	Short-term	Effect would likely occur during the Construction phase.
Reversibility	Reversible	Spending would not be detectable during the Operation phase due to the minimal workforce.
Frequency	Continuous	The effect would be ongoing during the Construction phase.
Confidence	High	There is a good understanding of how MC1 may create induced economic effects on regional businesses.

Change to Availability of Accommodation

Overall, the change in availability of accommodation in the region would likely be adverse, non-substantive and minor after mitigation, due to the work camp that is proposed for the Construction phase. Some workers may elect to rent or purchase homes in Bragg Creek or Redwood Meadows, or stay in campgrounds in the area, which may reduce the availability of these options for others. Other workers may commute from Calgary or other areas of the RAA. Confidence in the rating predictions is high. There is a good understanding of how MC1 would affect accommodation availability, considering the proposed on-site work camp as well as MC1's proximity to Bragg Creek and Elbow River Valley campgrounds. The effect characteristics ratings are summarized below in **Table 8.2-27**.

Table 8.2-27 Summary of Effect Characteristics Ratings for Change to Availability of Accommodation

Residual Effects Characteristic	Rating	Rationale for Rating
Direction	Adverse	Reduced availability would be an adverse effect.
Extent	Local	Limited to Bragg Creek and local campgrounds.
Magnitude	Minor	A minor effect on availability of accommodation is possible.
Duration	Short-term	Effect would occur during the Construction phase.
Reversibility	Reversible	Increased demand for accommodation would end after the Construction phase.
Frequency	Continuous	Accommodation availability may be an ongoing minor concern.
Confidence	High	There is a good understanding of how MC1 would affect accommodation availability.

8.2.3.5 Summary of Socio-economic Resources Assessment

Based on the effects characterizations provided above, residual effects are as follows:

- "Increase to provincial and regional economies" is a positive, substantive residual effect;
- "Change in labour force", "Change in contracting and procurement opportunities" and "Change to regional economic conditions" are positive, non-substantive residual effects;
- "Change in economic activities of resource-dependent businesses and industry" is an adverse, non-substantive residual effect; and
- "Change in availability of accommodation" is an adverse non-substantive residual effect.

No substantive adverse effects have been identified for Socio-economic Resources; therefore, none are carried forward for consideration in the planned Development Case (**Section 9.0 Planned Development Case**).

8.2.4 FOLLOW-UP MONITORING FOR SOCIO-ECONOMIC RESOURCES

If MC1 were to proceed through full regulatory approvals and into the Construction and Operation and Maintenance phases, follow-up socio-economic monitoring would likely be required. The purpose of follow-up monitoring for Socio-economic Resources would be to verify the potential socio-economic effects of MC1, and to determine the effectiveness of proposed mitigation measures.

A socio-economic monitoring program may be developed to 1) to verify the accuracy of the residual effects predictions, and the value of proposed mitigation measures; 2) assess the efficacy of proposed mitigation measures and the need for modifications to those measures to confirm that the effects predictions remain valid; 3) identify unexpected socio-economic outcomes or problems; and 4) implement additional mitigation measures as per adaptive management plans developed in support of MC1.

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8.3 PUBLIC HEALTH AND SAFETY

This section assesses potential MC1-related effects to Public Health and Safety, which include consideration of the potential adverse effects, associated with changes to the biophysical environment resulting from the construction and operation of the Elbow River at McLean Creek Dam (MC1) Option, as well as the potential benefits to health and regional health services associated with mitigating flood risk.

The assessments presented in this section are supported by or linked to the assessments presented in the following sections:

- Section 6.1 Atmospheric Environment
- Section 6.3 Hydrogeology
- Section 6.5 Water Quality
- Section 8.2 Socio-economic Resources
- Appendix 3-B 2017 Phase II Environmental Site Assessment.

8.3.1 SCOPE OF ASSESSMENT

This section reviews the scope of the assessment for Public Health and Safety, and includes the regulatory framework, data sources, measurable parameters, and assessment boundaries relevant for Public Health and Safety. The scope of this assessment relies on information compiled from the review of publicly available literature as well as past studies for the MC1 Option.

The health assessment presented in this section is similar in scope to a screening level risk assessment, whereby the potential for adverse effects to human health are examined for each potential pathway of exposure, considering the environmental media that could be affected by the MC1 Option. As such, the assessment focused on the health implications of activities that affect air quality and noise levels, although activities affecting water quality (groundwater and surface water) were also considered. In addition, the potential effect of MC1 on regional health services, the health risks associated with flooding, and aspects of the MC1 Option that may be a concern to public safety were evaluated.

8.3.1.1 Regulatory Framework

This section provides an overview of the relevant regulatory framework and requirements for potential MC1-related effects to Public Health and Safety, including health-based guidelines specific to air quality and noise (**Table 8.3-1**).

Table 8.3-1 Summary of Applicable Regulatory and Policy Framework for Public Health and Safety

Name	Jurisdiction	Description
Alberta *Occupational Health and Safety Act* (RSA 2000, c. O-2), Regulation (2013) and Code. 2009 (87/2009)	Provincial	This legislation provides rules governing health and safety at Alberta workplaces. Employers are required to ensure the health and safety of workers engaged or present at a work site.
Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) (Health Canada 2012)	Federal	This guidance document provides human health risk assessment guidance from Health Canada. Intended for contaminated sites but useful for assessing potential health risks from exposure to hazards (chemicals) in air, soil, and water.
Alberta Ambient Air Quality Objectives and Guidelines (AEP 2016a)	Provincial	This document provides direction on air quality objectives developed under the *Environmental Protection and Enhancement Act* to protect Alberta's air quality.
Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Alberta Environment and Parks (AEP 2016b)	Provincial	These guidelines present provincial guidance for managing contaminated soil and groundwater in Alberta.
Useful Information for Environmental Assessments (Health Canada 2010)	Federal	This document provides federal guidance for environmental assessments relating to the assessment of effects on human health, including air quality, drinking and recreational water quality, soil quality, and noise levels.
Directive 038: Noise Control Alberta Energy Regulator (AER 2007)	Provincial	This directive provides requirements for noise control for operations under the jurisdiction of the Alberta Energy and Utilities Board as well as general background information and approach to dealing with noise issues.
Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise (Health Canada 2016a)	Federal	This document provides federal guidance for the prediction of health risks related to noise.
Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta (Alberta Health and Wellness 2011)	Provincial	This provincial guidance is for human health risk assessment for new projects in Alberta as part of an Environmental Impact Assessment (EIA).
Guidelines for Canadian Drinking Water Quality. (Health Canada 2017)	Federal	These federal guidelines direct the protection of drinking water for human consumption.

Changes in ambient air concentrations of chemicals predicted to occur as a result of existing emission sources and future MC1-related emissions have been assessed, and airborne chemicals associated with MC1 emissions are identified in **Section 6.1 Atmospheric Environment**. For the purpose of the human health assessment, the chemicals identified were selected as chemicals of potential concern for the evaluation of human health risks, with the exception of chemical parameters that are related to climate change (i.e., greenhouse gases expressed as carbon dioxide equivalents and climate forcing particulate matter). The chemicals of potential concern identified for the MC1 Option include the following criteria air contaminants (CACs): respirable particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and carbon monoxide (CO).

Air quality management in Alberta is governed by Canadian Ambient Air Quality Standards (CAAQS) and Alberta Ambient Air Quality Objectives (AAQOs). The CAAQS and AAQOs, as well as air quality guidelines recommended by federal and international health agencies (i.e., Health Canada and World Health Organization), were reviewed to identify inhalation exposure limits protective of human health, including those individuals with existing respiratory conditions (e.g., asthma) and a greater sensitivity to changes to air quality (i.e., children and the elderly). The selected inhalation exposure limits for short-term (less than or equal to 24-hour average) and long-term (annual average) exposure periods and the health endpoints on which they were based are summarized below in **Table 8.3-2**. The analysis for potential health effects associated with exposure to air concentrations over short-term and annual averaging periods was conducted for all receptors identified in the Air Quality Local Assessment Area (LAA) (see **Section 8.3.1.5**).

Table 8.3-2 Inhalation Exposure Limits for the Protection of Human Health

Chemical	Exposure Duration (Averaging Period)	Exposure Limit (µg/m^3)	Health Endpoint	Source
$PM_{2.5}$	24-hr (CAAQS)	27[a]	Population mortality and morbidity	CCME 2012
	Annual (CAAQS)	8.8	Population mortality and morbidity	CCME 2012
NO_2	1-hour	188[b]	Respiratory (sensitive individuals)	US EPA 2012
	Annual	40	Respiratory	WHO 2006
SO_2	1-hour (CAAQS)	183[c]	Respiratory (sensitive individuals)	CCME 2016; US EPA 2012
	Annual (CAAQS)	13	Respiratory	CCME 2016
CO	1-hour (AAQO)	15,000	Carboxyhemoglobin formation in blood	AEP 2016a, Health Canada 1994

Notes:

[a] Based on 3-year average of the annual 98th percentile of the daily (24-hour) maximum PM2.5 concentrations, CAAQS effective in 2020

[b] Based on 3-year average of the annual 98th percentile of 1-hour daily maximum NO_2 concentrations

[c] Based on the 3-year average of the annual 99th percentile of 1-hour daily maximum SO_2 concentrations, CAAQS effective in 2020

Changes in ambient noise levels were assessed against health-based thresholds recommended by the WHO (2009) and Health Canada (2016a). The noise metrics considered in this assessment include percent highly annoyed (%HA), annual average night sound level (Ln), and normalized outdoor day-night sound level (Ldn). These noise thresholds and the health endpoints on which they were based are summarized below in **Table 8.3-3**.

The primary indicator for potential health effects associated with noise is %HA because it has been the focus of extensive epidemiological studies of noise over the last three decades and there is a well-established quantitative relationship between noise exposure and adverse human health effects based on this metric (Schultz 1978, Fidell et al. 1991, Michaud et al. 2008).

Another indicator of potential health effects associated with noise is annoyance associated with low-frequency noise. Noise in the 10-hertz to 200-hertz frequency range is considered LFN and can result in annoyance and sleep disturbances in individuals sensitive to its effects (Leventhall 2004). A greater than 20 decibel (dB) difference between C- and A-weighted sound predictions is an indication that the low-frequency energy in noise may be a concern (AER 2007). Although not a predictor of annoyance (Kjellberg et al. 1997), this measurement is useful for determining the potential for health concerns associated with LFN (Leventhall 2004). When the difference between C- and A-weighted sound levels exceeds 10 dB it is recommended that a more sophisticated mathematical procedure be used to assess %HA (Health Canada 2016a).

Table 8.3-3 Noise Thresholds for the Protection of Human Health

Sound Measurement	Noise Threshold	Endpoint	Source
Change in %HA	6.5%	Chronic high annoyance – stress, sleep disturbance effects	Health Canada 2016a
Annual Average Ln	40 dBA	Sleep disturbance effects (e.g., increased fatigue, irritability, decreased concentration and performance)[1]	WHO 2009
Normalized outdoor daytime sound (Ld)	55 dBA	No adverse health effect	Health Canada 2016a
Ldn	62 dBA[2]	Widespread noise complaints – stress, sleep disturbance effects	Health Canada 2016a

Notes: [1] chronic sleep disturbance can lead to cardiovascular effects, mental health effects and accidents
[2] at 75 A-weighted decibels (dBA) noise mitigation is required

The potential health effects associated with existing conditions and MC1-related changes to water quality were qualitatively assessed following review of data from the following sections of the MC1 Environmental Impact Screening (EIS) Report: **Appendix 3-B 2017 Phase II Environmental Site Assessment, Section 6.5 Water Quality**, and **Section 6.3 Hydrogeology**. These sections outline the applicable provincial (i.e., Alberta Tier 1 guidelines for soil and groundwater quality) and federal (i.e., Canadian drinking water quality guidelines) health-based guidance documents, and provide detailed comparisons of existing (i.e., Baseline Case) and expected (i.e., Application Case) conditions within the context of these guidelines.

8.3.1.2 Data Sources

Data sources for the assessment of Public Health and Safety included MC1-specific data, government databases, as well as scientific literature such as journal publications and white papers. The following data sources were reviewed:

- Environmental Overview of the Conceptual Elbow River Dam at McLean Creek (AMEC 2015)
- Cougar Creek Debris Flood Retention Structure, EIA (Town of Canmore 2016)
- Site C Clean Energy Project Environmental Impact Statement, Volume 4 – Section 33 (BC Hydro 2013)
- Recommendations on the Elbow River Major Infrastructure Decisions (AEP 2015)
- Flood Hazard Map Application (AEP 2016c)
- Public Health Adaptation to Climate Change in Canadian Jurisdictions (Austin et. al. 2015)
- Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation (Warren and Lemmen 2014)
- Global Change and Public Health: Addressing the Ecological Determinants of Health (Hancock et al 2015)
- Factors Increasing Vulnerability to Health Effects before, during and after Floods (Lowe et al 2013)
- Comparative Risk Assessment of Burden of Disease and Injury Attributable to 67 Risk Factors and Risk Factor Clusters in 21 Regions, 1990 – 2010: A Systematic Analysis for the Global Burden of Disease Study 2010 (Lim et al. 2012)
- Health Impacts of Floods (Du et al. 2010).

The assessment of Air Quality and Noise lacks technical details related to: MC1-specific emissions to the atmosphere; region-specific modelling assessment of ground level air concentrations, and; detailed information on construction equipment requirements. In the absence of MC1-specific data, emissions and noise sources were estimated using information contained in the Site C Clean Energy Project EIS (BC Hydro 2013). The Site C Clean Energy Project was chosen because project components and emission sources are similar to those expected for the MC1 Option. The air and noise assessments from the Site C Clean Energy Project were adapted for MC1 based on relative size.

Should the MC1 Option proceed, a refined assessment of atmospheric effects would be conducted. This refined assessment would be based on detailed design information, and would include a full inventory of MC1-related air and noise emissions as well as a detailed modelling exercise, in line with atmospheric assessments for other EIAs.

The Surface Water Quality Valued Component (VC) was limited to a screening level effects assessment since baseline studies were not conducted to quantify parameters of the Elbow River affecting surface water quality. A detailed baseline surface water quality program would be developed if this Option proceeds.

8.3.1.3 Valued Components

Public health and safety may be affected by MC1-related changes to air quality, noise levels, drinking water quality and regional health services. The potential changes related to MC1 construction and operational activities may interact directly with public safety. Completion of the MC1 would mitigate flood risks downstream of the MC1 site, which would directly affect public health and safety (**Table 8.3-4**)**.**

Table 8.3-4 Valued Components for Public Health and Safety

Valued Component	Interaction
Public Health and Safety	Components and/or activities of the Option may directly or indirectly influence the health and safety of individuals residing or recreating in the vicinity of MC1.

8.3.1.4 Measurable Parameters

Measurable parameters are quantitative or qualitative measures used to describe existing conditions and trends, and evaluate potential MC1-related effects on a VC. The measurable parameters selected for Public Health and Safety are shown in **Table 8.3-5**. Potential adverse MC1-related effects on the VC arising from potential interactions are discussed in more detail in **Section 8.3.3**.

Table 8.3-5 Measurable Parameters for Public Health and Safety

Selected VC	Potential MC1-related Effect	Measurable Parameter
Public Health and Safety	Health effects from changes in air quality	Predicted air concentrations of CACs (Air Quality VC)
	Health effects from changes in noise levels	Predicted noise levels (i.e., Ldn, Ln, and %HA) (Noise VC)
	Health effects related to drinking water quality	Water quality parameters (Water Quality VC) Groundwater quality parameters (Groundwater Quality VC) Soil quality parameters
	Effects on regional health services	Capacity of existing regional health facilities Flood risks to health and safety
	Public safety	Hazards to public safety during construction and operation
	Emergency preparedness and response	Hazards to public safety during emergencies Flood risks to health and safety

8.3.1.5 Assessment Boundaries

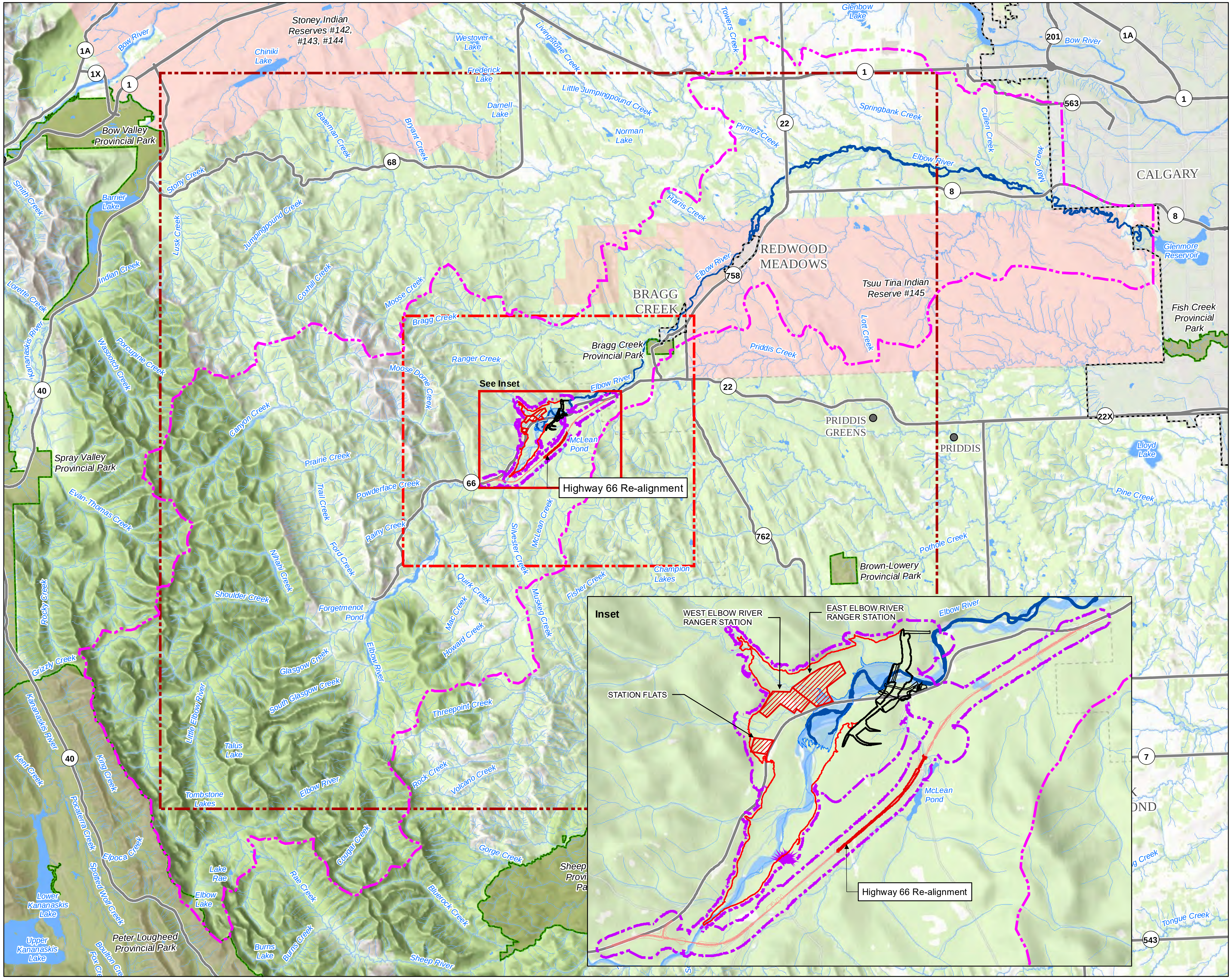
This section describes the spatial and temporal boundaries of the public health and safety assessment.

Spatial Boundaries

The Public Health and Safety assessment has two areas of focus: the area directly affected by the proposed works, relocations, and new construction and the downstream area that would be influenced by the attenuation of flooding by the Option. Spatial boundaries for the assessment are described in **Table 8.3-6**. The LAA encompasses the maximum geographical area where the proposed works, relocations, and new construction of the Option is expected to interact and potentially have a direct or indirect effect on Public Health and Safety. The Regional Assessment Area (RAA) encompasses the areas where the MC1 Option is expected to interact with and potentially affect the regional atmospheric environment, regional health services, and emergency preparedness and response. The RAA was established to provide a regional context for the assessment of MC1-related effects primarily associated with the benefits of reducing flood risk. The RAA also encompasses the area within which the residual effects of the Option are likely to interact with the residual effects of other past, present, or future projects or activities to result in a cumulative effect or effects (see **Figure 8.3-1**).

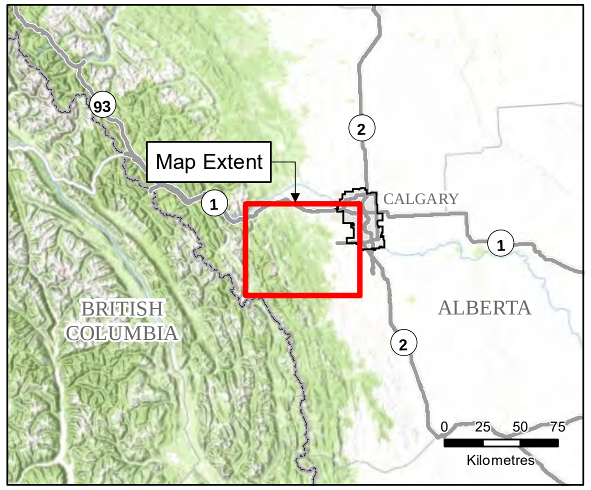
Table 8.3-6 Spatial Boundary Definitions for Public Health and Safety

Spatial Boundary	Description of Assessment Area
Option area	Encompasses the Option footprint and a 100-metre buffer.
Local Assessment Area	Atmospheric Environment: Option footprint plus 5-km buffer from the Option area. Water Quality: includes the Elbow River from the upstream extent of the reservoir formed by the MC1 dam down to the upstream extent of the Glenmore Reservoir Health Services and Emergency Preparedness and Response: Bragg Creek.
Regional Assessment Area	Atmospheric Environment: Extends 20 km from the Option area. Water Quality: Elbow River Watershed from headwaters to the upstream extent of the Glenmore Reservoir. Health Services and Emergency Preparedness and Response: Bragg Creek, Redwood Meadows, and the City of Calgary



Elbow River at McLean Creek Dam (MC1)

Public Health and Safety Local Assessment Area and Regional Assessment Area



Legend

- MC1 Option Area
- Air Quality Local Assessment Area
- Air Quality Regional Assessment Area
- Water Quality Local Assessment Area
- Water Quality Regional Assessment Area
- 2013 floodline, 2013 floodline at 1424m
- MC1 Dam
- 2013 Flood Event (1424.1m)
- Permanent Pond
- Hamlet
- First Nations Reserve
- Provincial Park
- Urban Area
- Highway
- Watercourse
- Waterbody

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Basedata: Government of Alberta
- Dam and flood details: Opus International Consultants Limited, 2017
- Background Image: ESRI World Topographic Map
- Inset Maps: ESRI World Topographic Map

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Human Receptors within the Local Assessment Area

Discrete public receptor locations were identified for the assessment of potential health effects related to changes in air quality and noise on residents or individuals involved in recreational activities within the LAA. The air quality (AQ) and noise receptors (NRs) included in the assessment are described below in **Table 8.3-7** and illustrated in **Section 6.1 Atmospheric Environment** (**Figures 6.1-1 and 6.1-2)**, respectively. The Allen Bill day use area is not identified as a sensitive public receptor location since this area would be decommissioned and removed as part of the MC1 Option. Residences in the Elbow Valley Ranger Station (EVRS) were also not identified, as these would be decommissioned and removed during the MC1 Construction phase.

In addition to the discrete receptors identified, MC1 is an option to provide flood protection which would protect the health and safety of individuals residing in the flood zone of Bragg Creek (see **Section 8.3.2**), as well as Redwood meadows and the City of Calgary. The MC1 Option could result in changes to surface water quality such that health-based drinking water guidelines are exceeded, posing health risks for users consuming surface water downstream of the Option.

Table 8.3-7 Discrete Public Receptor Locations in the Local Assessment Area

Receptor Identification	Receptor Description	Receptor Location	
		Easting	Northing
AQ1	Proposed construction camp: temporary residence during construction	662605	5640178
HNR1	McLean Creek Campground	663076	5639574
HNR2	Building in Mclean Creek Public Land Use Zone	661629	5637977
AQ2	McLean Creek Campground	663203	5640010
NR2	McLean Creek Campground	663617	5640569
NR3	McLean Creek Campground	663062	5640247
AQ3, NR1	Easter Seals Camp Horizon	664492	5641960
AQ4, HNR4	Gooseberry Campground/Elbow Valley Visitors Information Centre	666466	5642786
AQ5, HNR3	Paddy's Flat Campground	660122	5637885
AQ6, NR4	Station Flats Day Use Area	661465	5640733
AQ7	West Bragg Creek Day Use Area	662091	5646627
AQ8, NR5	Closest Bragg Creek residence (Highlands)	665054	5643802
AQ9, NR6	Rural residence	668397	5641944
AQ10, NR7	Rural residence	669201	5642738

Temporal Boundaries

The temporal boundaries of the Option consist of the Construction and Operation and Maintenance phases of the Option, as described in **Section 3.0 MC1 Option Description**.

Administrative Boundaries

Administrative boundaries (e.g., political, economic, or social issues, as well as fiscal or other resourcing issues that may constrain the assessment of potential effects of the MC1 Option) have time and space limitations imposed because of administrative or economic reasons. An administrative boundary to the Public Health and Safety assessment is related to baseline health data for communities within the LAA which were best represented by Alberta Health Services (AHS) data for the Calgary zone – "Rural West".

Technical Boundaries

Data limitations related to the assessment of the Air Quality VC, Noise VC and Surface Water Quality VC are discussed in **Section 8.3.1.2**. Engagement with stakeholders that could be affected by MC1 prior to completion of the EIS was not conducted. In the absence of stakeholder input for the MC1 Option, public feedback for similar projects was reviewed, including the Cougar Creek Debris Flood Retention Structure (Town of Canmore 2016) and the Springbank Offstream Reservoir Project (SR1 Project).

8.3.2 BASELINE CASE

The Baseline Case for Public Health and Safety is presented for the RAA and LAA using data compiled from the sources listed in **Section 8.3.1.2**.

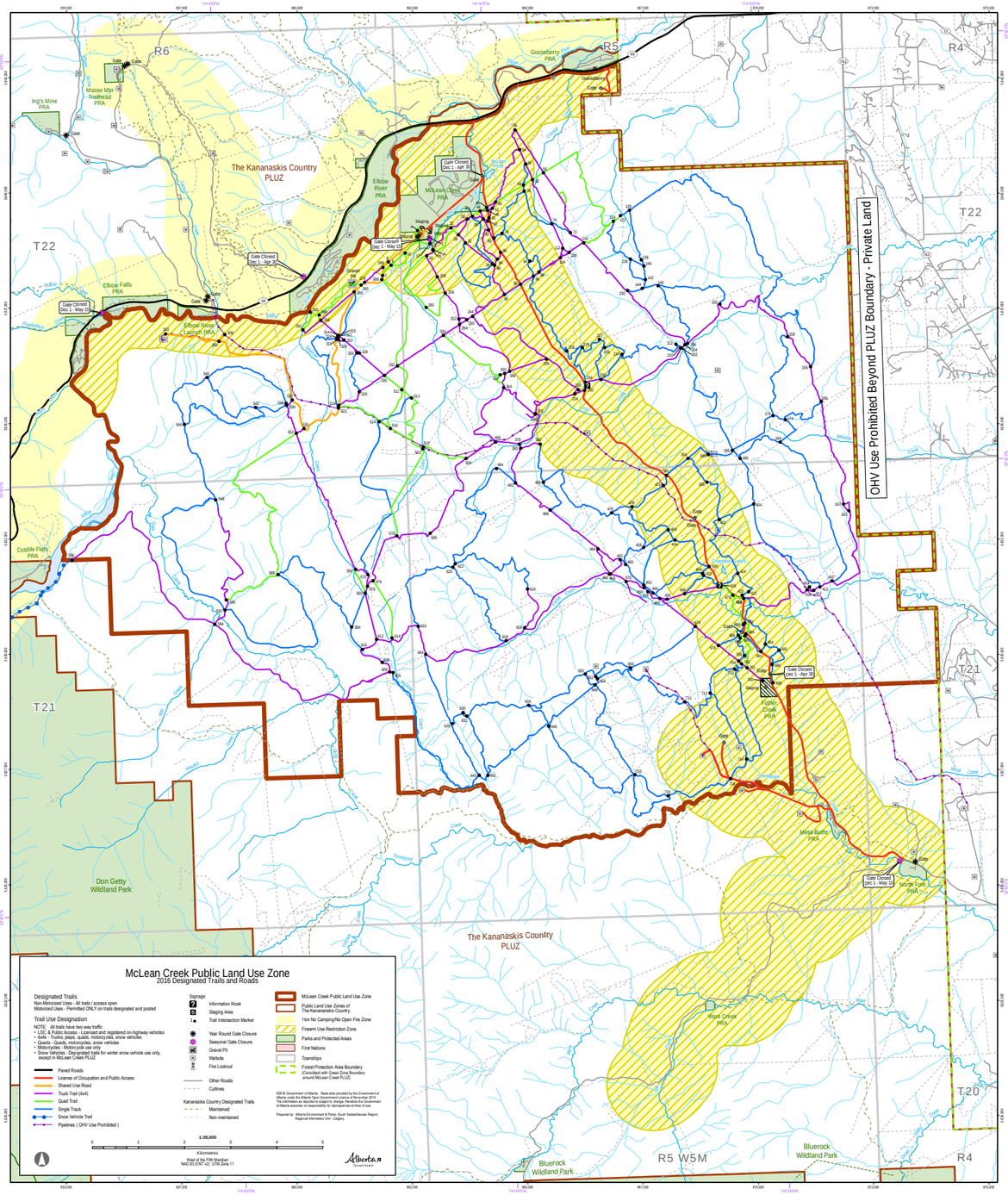
8.3.2.1 Existing Land Use

The Option site is located within Kananaskis Country, in the Foothills of the Eastern Slopes of the Rocky Mountains, which is largely protected as a park, ecological reserve, or recreation area but also allows for commercial activities such as cattle grazing, timber harvesting, and gas extraction (Alberta Parks 2017a). Most of the land near the Option area is public land that is administered by Alberta Environment and Parks (AEP). The McLean Creek public land use zone (PLUZ) allows for use of trails with off-highway vehicle trails within a 202-square-kilometre area (km^2) that includes the Option area.

Figure 8.3-2 illustrates land use in and around the McLean Creek Provincial Recreation Area, including the PLUZ (Alberta Parks 2017b).

Elbow River at McLean Creek Dam (MC1)

McLean Creek Public Land Use Zone



Legend

Refer to main map

Notes

1. This map is not intended to be a “stand-alone” document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Main Map: Alberta Environment & Parks, South Saskatchewan Region, Regional Informatics Unit - Calgary.

Scale: Refer to main map

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As previously identified in **Section 8.3.1.5**, this assessment is not informed by engagement with landowners and stakeholders that could be affected by the Option, specifically community members immediately downstream of the MC1 Option, including members of the Tsuut'ina Nation. Stakeholders affected by construction or a disruption in roadway access also include industrial, commercial, and agricultural leaseholders, as well as individuals involved in camping and recreational activities in the region (e.g., Easter Seals Camp Horizon, Elbow Falls, local hiking trails and campgrounds).

Given the lack of MC1-specific stakeholder engagement, key public health and safety concerns associated with MC1 construction and operation were identified using professional judgement and considering similar projects proposed for flood mitigation in Alberta where stakeholder input was provided (e.g., Cougar Creek Debris Flood Retention Structure and the SR1 Project).

Key issues identified in stakeholder meetings for the Cougar Creek Debris Flood Retention Structure centered on accelerating construction and completion of the Option to reduce future flood risk. No issues specific to human health were raised in terms of MC1 construction or operation, and no issues regarding traditional lifestyle were raised by Indigenous communities (Town of Canmore 2016). In the case of the SR1 Project, the Tsuut'ina Nation identified issues related to the potential for flooding in areas of traditional territory and reserve land and the potential impacts to key resources on which Tsuut'ina community members rely, including fish, wildlife, vegetation, and water, as well as safety and risk considerations associated with harvesting these resources (Whitney, Pers. Comm., 2016).

8.3.2.2 Regional Health Services

Alberta Health Services is responsible for delivering health services to the residents of Alberta. The hamlet of Bragg Creek, Redwood Meadows and the Tsuut'ina Nation are located closest to the Option area. These communities and the City of Calgary would benefit from flood protection provided by the Option.

Health services in Bragg Creek (and by association Redwood Meadows) are provided by a clinic that operates under Mountain Woods Health Services in association with the Calgary Rural Primary Care Network (PCN). Health services on the Tsuut'ina Nation are provided by the Tsuut'ina Clinic which is supported by the Calgary West PCN. The Alberta government, Alberta Medical Association and Alberta's Regional Health Authorities (now AHS) established the Primary Care Initiative in 2003, which in turn developed PCNs to improve access to doctors and frontline health care providers. The PCN includes a network of doctors, nurses, dietitians, and pharmacists who work together to provide primary health care. Alberta Health Services is responsible for the delivery of health services within Calgary and outlying areas. The Calgary zone includes eight hospitals, five urgent care centres, five cancer care centres, seven PCNs, 11 public health centres, and 42 addiction and mental health centres (PCN 2017).

8.3.2.3 Baseline Health

Baseline health data for the region in the immediate vicinity of MC1 (i.e., Bragg Creek) are best represented by AHS data for the Calgary zone – "Rural West" (Z2.7B) (Predy et al. 2011). Key health indicators reported for the rural west zone associated with changes in air quality include mortality related to heart and respiratory disease, including ischemic heart disease (IHD), cerebrovascular disease, chronic obstructive pulmonary disease (COPD), lung cancer and lower respiratory infections (Lim et al. 2012; Cohen et al. 2017). Individuals with existing lung conditions (e.g., asthma, COPD, lung cancer) or heart conditions (e.g., arrhythmia, angina, history of heart attack) have greater sensitivity to changes in air quality, as well as the very young and elderly whose lungs and immune systems are more susceptible to contaminant exposure (Health Canada 2016b). Health effects related to stress and annoyance as a result of noise levels include cardiovascular disease, cognitive impairment, and sleep disturbance (WHO 2011).

Data available from AHS (Predy et al. 2011) were used to compare health indicators for the population in the Option area (rural west zone) to the population of Calgary and the population of the province of Alberta as a whole (**Table 8.3-8)**. The 2007-2008 age standardized incidence rates (per 100,000 individuals) for mortality associated with heart disease (including IHD) and lung cancer are lower for the rural west zone compared to the Calgary zone and the province of Alberta. The incidence rate for mortality associated with COPD is higher for the rural west zone compared to the Calgary zone and the province of Alberta. The incidence rate for mortality associated with respiratory disease in the rural west zone is higher compared to the Calgary zone and lower compared to the province of Alberta. Respiratory health effects are among the top seven reasons for emergency department visits in 2009 in all three areas (rural west, Calgary, and Alberta) and among the top seven reasons for hospitalization between 2007 and 2009 in the rural west zone and in Alberta as a whole.

Table 8.3-8 Health Profile Data: Rural West Zone, Calgary Zone, and Alberta

Health Characteristic	Rural West Zone	Calgary Zone	Alberta
All Heart Disease – ASMR	75.6	113.0	120.8
IHD – ASMR	57.5	91.6	94.5
Lung Cancer – ASMR	18.7	33.5	38.5
COPD - ASMR	26.5	22.2	24.9
Respiratory – ASMR	46.9	41.4	48.0
Top 7 overall reasons for emergency department visits: respiratory health effects	12.3%	13.2%	13.8%
Top 7 overall reasons for hospitalization: respiratory health effects	7.6%	n/a	6.5%

Source: Predy et al. 2011
Notes: 2007-2009 ASMR – age standardized mortality rate (per 100,000) to 1991 Canadian Population

Statistics Canada (2013) reported mental health and stress data, as well as incidence data (% occurrence) for health characteristics relevant to air quality (e.g., asthma and COPD) for the Calgary zone and the province of Alberta. Health indicators relevant to changes in air quality and noise are summarized below in **Table 8.3-9**. Overall, the Calgary zone reported a higher incidence of very good or excellent perceived mental health as well as lower perceived life stress and mental illness hospitalization rates, relative to Alberta. The incidence rate for other health endpoints (asthma, blood pressure, COPD, lung cancer, and smoking) were lower for Calgary compared to Alberta.

Table 8.3-9 Health Profile Data: Calgary Zone and Alberta

Health Characteristic	Calgary Zone	Alberta
Perceived mental health; very good or excellent (%)	76.3	72.9
Perceived life stress (%)	23.6	23.9
Mental illness hospitalization rate (per 100,000 population)	376	427
Asthma (%)	7.2	8.3
High blood pressure (%)	14.6	15.5
COPD (%)	2.9	3.6
Lung cancer incidence (per 100,000 population)	48.9	50.9
Current smoker; daily or occasional (%)	19	21.6

Source: Statistics Canada 2013

8.3.2.4 Existing Air Quality

The existing air quality within the LAA and RAA is described in detail in **Section 6.1 Atmospheric Environment**. In summary, air quality in the LAA is predominately affected by emissions related to industrial activity (oil and gas facilities), agricultural activity, and highway traffic. Ambient air concentrations of two CACs (i.e., NO_2 and SO_2) were measured at a Bragg Creek passive monitoring station from 2011 to 2015. In the absence of local data for respirable particulate matter ($PM_{2.5}$), ambient data from a monitoring station in Caroline, Alberta were selected to represent baseline $PM_{2.5}$ air concentrations in the LAA. The Caroline station is in a similar remote setting with several oil and gas facilities within a 5-kilometre (km) radius. The $PM_{2.5}$ results from this station are considered to be a conservative estimate for the Bragg Creek area, considering the proximity to the Shell Caroline complex (i.e., in 2015, the annual $PM_{2.5}$ emissions in the National Pollutant Release Inventory was 6.6 tonnes from the Shell Caroline complex compared to 2.9 tonnes for the facilities in the LAA for air quality) (ECCC 2016). As described in **Section 6.1 Atmospheric Environment**, there are no monitoring data to describe ambient CO concentrations in the LAA, which are assumed to be zero. The air concentrations summarized in **Table 8.3-10** were selected to represent baseline air quality conditions at each of the discrete receptor locations in the LAA. All predicted air concentrations for the Baseline Case scenario are below thresholds for the protection of human health.

Table 8.3-10 Background Air Quality Concentrations at Receptor Locations

Contaminant	Averaging Period	Background Concentration (µg/m^3)	Source
$PM_{2.5}$	24-Hour	10	Caroline, AB
	annual	3.7	Caroline, AB
NO_2	1-Hour	2.8	Bragg Creek, AB (maximum)
	annual	0.8	Bragg Creek (50th percentile)
SO_2	1-Hour	10	Bragg Creek (maximum)
	annual	1.1	Bragg Creek (50th percentile)
CO	1-Hour	0	Assumed

8.3.2.5 Existing Noise Levels

The existing noise levels within the LAA and RAA are described in detail **Section 6.1 Atmospheric Environment**. In summary, noise in the LAA is affected by emissions from agricultural activity, traffic, residential, and recreational activity. Industrial facilities in the RAA include the Shell Canada's Moose Mountain and Husky Oil's McLean Creek North Compressor Stations. Baseline noise measurements were not collected; therefore, existing noise levels are assumed to be consistent with ambient sound levels described by Alberta Energy Regulator's Directive 038: Noise Control (AER 2007). An ambient sound level represents the average sound environment without anthropogenic sources, and is determined by the number of dwellings and the proximity to transportation corridors (AER 2007). These values are within the same range as the day-night sound level considered by Health Canada (2016a) to be representative of a quiet suburban or rural community (i.e., Ldn range of 48 A-weighted decibels (dBA) to 52 dBA, average 50 dBA). Baseline sound levels are reported for each discrete NR location in **Table 8.3-11**. All of the predicted noise levels for the Baseline Case are below thresholds for the protection of human health (i.e., %HA, Ln, Ldn).

Table 8.3-11 Baseline Sound Levels at Noise Receptors

Receptor(s)	Baseline Sound Levels		Category and Dwellings
	Day Ld (dBA)	Night Ln (dBA)	
NR2, NR4, NR6, NR7, HNR2, HNR3	45	35	Category 1, 1 to 8 dwellings
HNR1, NR3, NR5	48	38	Category 1, 9 to 160 dwellings
NR1	50	40	Category 2, 1 to 8 dwellings
HNR4	53	43	Category 2, 9 to 160 dwellings

8.3.2.6 Existing Water Quality

Groundwater samples representative of the local aquifer were collected in 2014 from three wells (Camp Horizon ID#1020984, Camp Horizon ID#1020988, Kananaskis Country #3259 ID#350009) and analyzed for routine parameters (including major cations and anions), dissolved and total metals, sulphides, nutrients, phenols, and coliforms (AMEC 2015). The concentrations of all measured groundwater parameters are below Federal Guidelines for Drinking Water Quality (Health Canada 2017).

Local groundwater use is described in detail in **Section 6.3 Hydrogeology**. Domestic use of groundwater from the surficial (alluvial) aquifer is limited but does occur. Wells in this aquifer are connected to surface water in the Elbow River and susceptible to surface contamination. The deeper bedrock aquifer (sandstone units in the Brazeau formation) that are overlain by confining layers and thereby less susceptible to surface contamination would be preferred sources for domestic use. As concluded in **Section 6.3 Hydrogeology,** there is no evidence of anthropogenic effects on groundwater quality from current land use, although groundwater contamination can occur as a result of poor well completions and inadequate maintenance of septic systems, as reported in the hamlet of Bragg Creek by the Elbow River Watershed Partnership (2008).

Baseline surface water quality conditions were determined from water samples collected at two locations on the Elbow River (upstream of Bragg Creek and at the Highway 22 Bridge) between 1998 and 2015, as described in **Section 6.5 Water Quality**. Mean chemical concentrations were generally below health-based maximum acceptable concentrations for drinking water quality (Health Canada 2017). For total mercury, the mean concentration and 95% confidence interval values reported for water samples collected from upstream of Bragg Creek (23 samples between 2004 and 2006) and water samples collected at the Highway 22 Bridge (76 samples between 1999 and 2006) was equal to the health-based drinking water guideline (i.e., 1.0 micrograms per litre (µg/L)). A standard deviation of zero was reported for both data sets suggesting that the method detection limit for analysing total mercury was equal to the drinking water guideline (i.e., 1.0 µg/L) and the concentration of total mercury was assumed to equal to the detection limit. Mean pathogen levels (total coliforms) are above health-based drinking water quality guidelines upstream of Bragg Creek (199 samples between 1998 and 2015) and at the Highway 22 Bridge (370 samples between 199 and 2015). These contaminants are likely associated with ruminant animals (including cattle and deer) present upstream of the Option area in the Elbow River watershed.

The Elbow River provides nearly half of the water supply for the City of Calgary (i.e., Glenmore Reservoir). Although surface water would undergo water treatment prior to consumption, the maintenance of surface water quality in this region is integral to the maintenance of public health and safety.

Elbow Valley Ranger Station

A Phase II Environmental Site Assessment was conducted at the EVRS **(see Appendix 3-B 2017 Phase II Environmental Site Assessment).** The area is comprised of a west EVRS and east EVRS. Part of the east EVRS area would be covered by the permanent pond and the entire east EVRS and west EVRS areas are located within the June 2013 flood zone, as illustrated in **Figure 3.3-1 Option Layout**.

The EVRS has been present in various capacities since the 1920s, serving as a base for housing and park administration for AEP, Alberta Forestry, Alberta Fisheries and Wildlife, and Kananaskis Country Campgrounds. The station has also served as the major base for firefighting operations in the area since the 1980s. There is a water and sewage treatment system in place at the west ranger station, including two associated septic fields, which provides services for the ranger station, McLean Creek Campground, and Camp Horizon **(**see **Appendix 3-B 2017 Phase II Environmental Site Assessment)**.

Soil and groundwater contamination (i.e., concentrations above Alberta Tier 1 coarse soil guidelines for natural areas/parkland use were detected in the west EVRS (AEP 2016b), which includes the fire base, sewage treatment plant, fuel storage, and workshops. Specifically, soil contamination was identified at the helicopter fuel storage area (toluene at 3.5 metres (m) to 4 m below ground surface (bgs)) and the above-ground fuel storage tank area (naphthalene, phenanthrene, and pyrene, 2.3 m bgs to 7 m bgs), with marginal exceedances noted near the septic field areas (barium and nickel, 1.3 m bgs to 1.5 m bgs). Dissolved metal concentrations in alluvial groundwater exceed Alberta Tier 1 guidelines in above-ground fuel storage tank area (chromium, copper, manganese, nickel) and near a wash bay (manganese) (see **Appendix 3-B 2017 Phase II Environmental Site Assessment**).

The Tier 1 guidelines for exceedances in soil are based on protection of freshwater aquatic life (toluene, naphthalene, phenanthrene, and pyrene) or ecological soil contact (barium and nickel). None of the measured chemical concentrations in soil exceed guidelines based on human health (i.e., direct soil contact, vapour inhalation, or protection of domestic use aquifer). In the case of groundwater, the majority of Tier 1 guidelines exceeded are based on the protection of aquatic life (chromium, copper, nickel, nitrate, nitrite), with the exception of manganese, which is human health based (i.e., use of groundwater as a potable water source). The highest manganese concentrations in groundwater were attributed to degradation of polycyclic aromatic hydrocarbons (PAH) in soil near the above-ground fuel storage tank. As concluded in **Appendix 3-B 2017 Phase II Environmental Site Assessment)**, soil effects in the helicopter fuel cache and above-ground fuel storage tank areas were not fully delineated.

8.3.2.7 Existing Health Risks Associated with Flooding

The purpose of the MC1 Option is to safeguard public health and safety by reducing the risks associated with flooding and its aftermath. There is currently no substantial infrastructure in place to protect communities downstream of the MC1 Option (including Bragg Creek, Redwood Meadows, Tsuut'ina Nation,

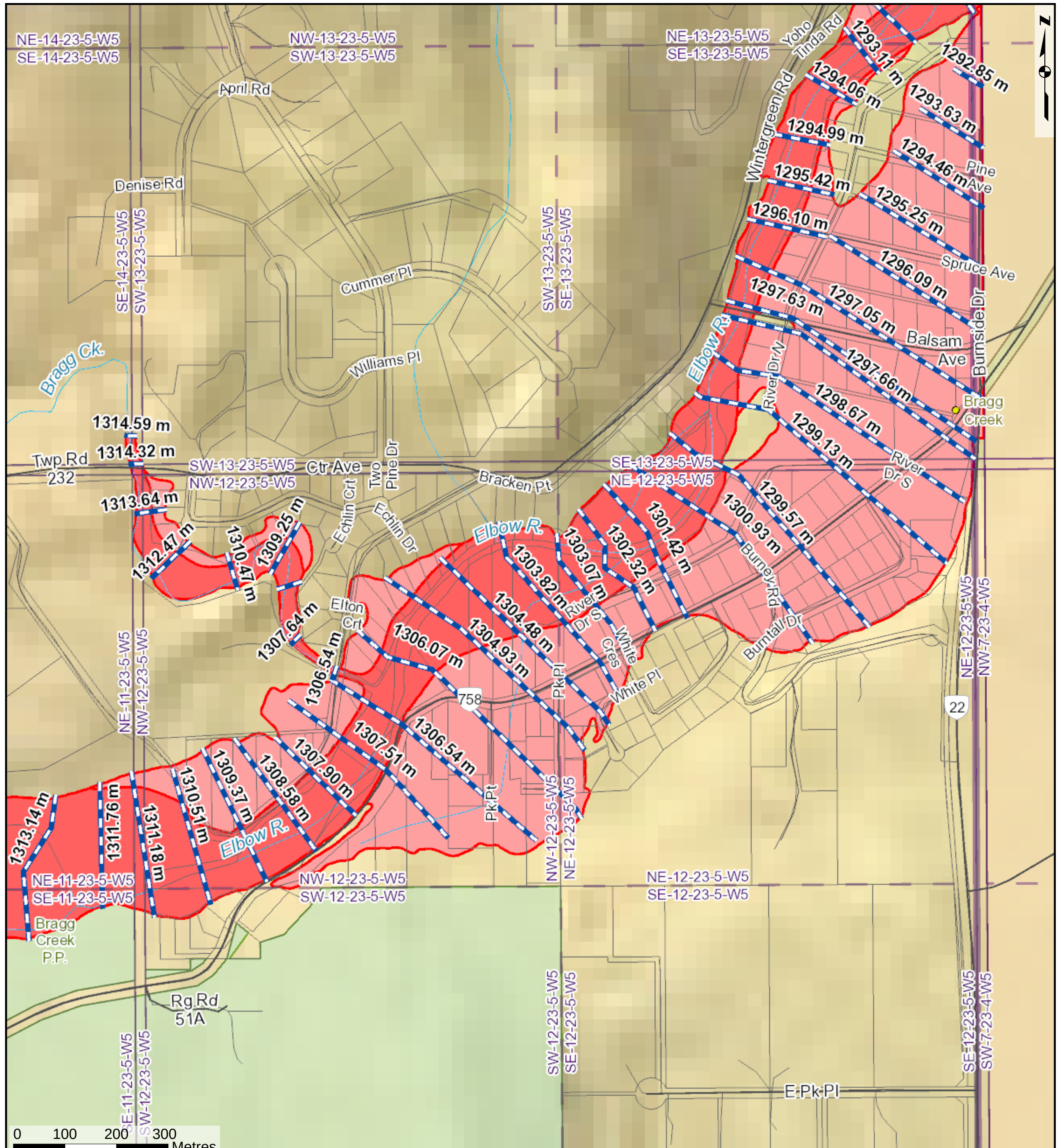
and Calgary) from flooding. Since flooding is classified as an extreme weather event that is exacerbated by climate change (Austin et al. 2015), these events are likely to increase in the future both in frequency and magnitude.

The 2013 flooding event in Alberta saw the Elbow River rise to over 200-year flood levels (Opus 2017), and required the mandatory evacuation of Bragg Creek (Government of Canada 2014). During this flood event, local states of emergency were declared in more than 30 communities resulting in the evacuation of over 100,000 Albertans. Five deaths were attributed to the flood (MNP 2015).

This type of extreme flooding may be heightened by events associated with climate change, including earlier spring runoff, increasing storm surges, and heavy precipitation (Warren and Lemmen 2014). The community of Bragg Creek is closest to the headwaters of the Elbow River and the MC1 Option. Bragg Creek experienced substantial infrastructure damage during the 2013 flood, including shut-down of a major bridge, which left sections of the community (i.e., West Bragg Creek and Wintergreen) isolated with no emergency access route (Government of Canada 2014). The flood hazard for Bragg Creek is available from AEP (2016c) and illustrated in **Figure 8.3-3.**

Elbow River at McLean Creek Dam (MC1)

Flood Hazard in Bragg Creek



Legend

Floodway	Under Review	First Nation Boundary
Flood Fringe	855.09 m Cross Section and Design Flood Level	Municipal Boundary
Overland Flow (Flood Fringe)	Water Body	

Information as depicted is subject to change, therefore the Government of Alberta assumes no responsibility for discrepancies at time of use.
Cadastral data provided by Alberta Data Partnerships Ltd. (ADP)
Base Map Data provided by the Government of Alberta under the Alberta Open Government License. November, 2014
National Framework Data © Department of Natural Resources Canada. All rights reserved.
Alberta Road Network data provided by GeoBase ®
Alberta Environment and Parks

Projection:	Datum:	Date:
ALBERTA 10TM	NAD 83	2017-Mar-22

maps.srd.alberta.ca/floodhazard/

Legend

Refer to main map

Notes

1. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Flood Hazard Map downloaded from maps.srd.alberta.ca/floodhazard/ 2017-MAR-22

Scale: Refer to main map

Page Size: 11" x 17"

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The adverse health effects associated with flooding events are recognized globally. Evidence observed in Canada suggests an increase in adverse health effects related to extreme weather events, with flooding being one of the most frequent types of extreme weather events (Austin et al. 2015; Warren and Lemmen 2014). The WHO recognizes direct and indirect health effects associated with flooding, varying from physical harm in the short-term to delayed mental health problems in the long-term (Hancock et al. 2015).

Direct health effects are associated with the actual flooding event and the time immediately after, including drowning and injuries caused by the flood water and flood debris. Indirect health effects are longer term and may take longer to manifest, including effects on mental health as a result of displacement and disruption (Menne and Murray 2013). Examples of direct and indirect health effects associated with flooding are provided in **Table 8.3-12** and described below.

Table 8.3-12 Potential Health Effects of Flooding

Type of Effect	Health Effect
Direct: effects on people exposed to flood water	Drowning and injuries from walking or driving through flood water, contact with debris in flood water, falling into hidden manholes, injuries from submerged objects, injuries while trying to move possessions during floods Building collapse and damage (injuries) Electrocution Diarrhoeal, vector, and rodent-borne diseases Respiratory, skin, and eye infections Chemical contamination, particularly CO poisoning from generators used for pumping and dehumidifying Water shortages and contamination due to loss of water treatment works and sewage treatment plants Stress, short- and longer-term mental health issues, including the effects of displacement
Indirect: effects of flood-water on other health determinants	Loss of access to and failure to obtain continuing health care Damage to health care infrastructure, and loss of access to essential care Damage to or destruction of property, including hospitals and other vital community facilities Damage to water and sanitation infrastructure Damage to crops, disruption of food supplies Disruption of livelihoods and income Population displacement Mental health problems due to length of flood recovery and fear of recurrence; indirect effects of stress in dealing with insurance claims and refurbishing properties

Source: Menne and Murray 2013

Direct health effects associated with flooding include contact with flood waters that can result in drowning, hypothermia, and bodily harm caused by debris or falling objects and collapsing buildings. Water shortage from infrastructure damage may result in dehydration or lead to consumption of water carrying harmful microorganisms. Electrocution is also a risk when taking shelter in buildings that are exposed to flood waters

(Du et al. 2010). The presence of water-borne infections such as diarrheal, vector, and rodent-borne disease may also increase during flooding. In addition, exposure to damp buildings may aggravate existing respiratory problems or lead to skin or eye irritation.

Run-off from roads, highways, and bridges within the flood zone can result in contaminant transport to surface water and groundwater. Potential contaminants of concern associated with run-off in an urban area may include hydrocarbons, PAH, and metals. In a rural area surface run-off may transport fertilizers, herbicides, and pesticides (Hancock et al. 2015). Contaminated flood waters can also transport sewage, agricultural soils, sediments, chemicals, or landfills runoff, which may be ingested via drinking water or contaminated foods resulting in gastrointestinal upset or infection. Contaminated flood water may also carry *Escherichia coli*, *Shigella*, *Salmonella* (Du et al. 2010) as well as microorganisms with longer incubation periods such as *Legionella pneumophila*, Norovirus, Rotavirus, and hepatitis A and C (Warren and Lemmen 2014). Flood waters from agriculture runoff could lead to algal blooms in local waterbodies, as a result of excess nutrients, which could alter aquatic ecosystems and affect human health (Du et al. 2010).

Indirect health effects associated with flooding are secondary delayed consequences of flooding that are more difficult to quantify, and may not appear for months or years after the event. These may include disruption or loss of access to public health services, infrastructure damage leading to contamination of water sources, population displacement, damage of livelihood and income, and extended mental health problems. The displacement of patients or staff and damage to health infrastructure may result in the loss of medical equipment and medical records (Du et al 2010, Hancock et al. 2015). Existing illness may be exacerbated by disruption of access to health services and infrastructure, impaired monitoring of existing illness, toxic exposure, or injury. Risk factors for adverse health effects include older age, chronic illness, and existing gastrointestinal or cardiac conditions (Lowe et al. 2013).

Evacuation and the disruption associated with it were reported to be the most substantial stressors of flooding (Hancock et al., 2015). In the United Kingdom after the 2000 flood, displacement was an important factor in mental disorders observed 10 months after the floods. In addition, loss and damage to property and possessions and financial concerns contributed to stress.

There is evidence that long term mental health issues arising from a flooding event are common in adults and children; manifesting as anxiety, depression, psychological distress, and post-traumatic stress disorder (Hancock et al. 2015). People who have been exposed to traumatic events such as flooding have been shown to have a four-fold higher risk of mental distress compared to those who have not been exposed (Du et al. 2010). Floods have been associated with a range of mental health problems, including violent behaviour (e.g., assaults) and substance abuse, and increased suicide risk (Warren and Lemmen 2014). Symptoms of psychosocial effects from an extreme weather event or disaster may take various forms such as alterations in mood, thoughts, or behaviour; an increased level of distress; and a reduction of one's ability to function in everyday life.

Adverse mental health effects are more likely to appear in those groups with greater vulnerability factors. Populations that are vulnerable to the health risks from flooding are described in **Table 8.3-13**.

Table 8.3-13 Factors that Affect Vulnerability

Factor that Increases Vulnerability	Population Group at Risk
Limited physical capacity	The elderly, children, people with chronic conditions or disabilities, or people who rely on home care
Limited mobility	The elderly, children, people with chronic conditions or disabilities, or people who rely on home care
Reliance on medication	The elderly, people with chronic conditions or disabilities, those who rely on home care, substance misusers
Reliance on regular home care	The elderly, people with chronic conditions or disabilities
Reliance on regular care at health facility	The elderly, people with chronic conditions or disabilities, substance misusers
Weak social networks	The elderly, people with chronic conditions or disabilities, those who rely on home care, are homeless or live alone, substance misusers, ethnic minorities, rural inhabitants
Poor flood awareness	All vulnerable health groups, those living in high-risk flood areas, those with a low income, ethnic minorities
Lack of resources for resilience and response	All vulnerable health groups, those living in high-risk flood areas, those with a low income, ethnic minorities
Little access to public warnings and guidance	The elderly, migrants and ethnic minorities, homeless people, tourists and visitors
High-risk built environment	People living in high-risk flood and deprived areas

Source: Menne and Murray 2013

The adverse health effects of large-scale flooding are varied and far reaching. They encompass immediate direct effects to the public and property and long-term indirect consequences to community and economy. Most flood-related effects can be preventable through education, prediction warning systems, and floodplain management (Du et al 2010). Recognizing the benefits of implementing strategies to counter the effects of flooding will lead to better safeguarding of public health and safety.

8.3.3 APPLICATION CASE

The Application Case describes the effects of the MC1 Option added to the Baseline Case (i.e., assesses the MC1-related effects). The following sections present the potential MC1-related interactions, effects, and mitigation measures, along with an assessment of residual effects.

8.3.3.1 Potential Option Interactions

Potential MC1-related interactions with Public Health and Safety and potential effects from each interaction are presented in **Table 8.3-14**.

Table 8.3-14 Identification of Potential Option Interactions with Public Health and Safety

Phase	Activity	Public Health and Safety	
		Interaction	Potential Effect
Construction	Vegetation/ground clearing	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Road construction	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality · Public safety · Effects on regional health services
	Decommissioning and removal of existing provincial parks infrastructure and ranger station	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality · Public safety · Effects on emergency preparedness and response · Effects on regional health services
	Dam (cofferdam and earth fill) construction	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality · Public safety
	Spillway construction	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Rock groin and diversion tunnels construction	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Laydown areas construction and use	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Stockpile development and use	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Borrow and spoil areas development and use	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality
	Realignment of McLean Creek and other small waterbodies	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality

Phase	Activity	Public Health and Safety	
		Interaction	**Potential Effect**
	Realignment of Highway 66	X	· Health effects from changes in air quality · Health effects from changes in noise levels · Health effects related to drinking water quality · Public safety related to construction activities · Effects on regional health services
	Storage of water in permanent pond	X	· Health effects related to drinking water quality
	Reclamation	X	· Health effects from changes in air quality · Health effects from changes in noise levels
Operation and Maintenance	Routine and flood operations and maintenance	X	· Health effects related to drinking water quality · Effects on emergency preparedness and response
	Storage of water in permanent pond	X	· Health effects related to drinking water quality · Public safety
	Flood storage reservoir – post-flood	X	· Health effects from changes in air quality

Note: X – potential interaction

Option construction would result in changes in air quality and noise levels due to dust emissions and use of vehicles and equipment. The MC1 Option would be built in an area typically used for recreational activities. Public safety would need to be managed during construction activities, particularly traffic management during road construction and managing access to the river and nearby trails for recreational use. There is a potential risk to the public if a flood should occur during construction and result in failure of partially constructed infrastructure. Emergency preparedness and response measures would be developed to protect public health and safety during flood operations.

Changes to local groundwater or surface water quality from MC1 construction or operation could affect drinking water quality downstream of the Option. Water storage in a permanent pond during operation and maintenance could result in recreational use of the water body, which may require management to protect public safety. In addition, the suspension of particulate matter from the banks of the flood storage reservoir after a flood (i.e., once flood waters have receded) could result in suspension of respirable particulate matter affecting local air quality and human health.

8.3.3.2 Potential Option-related Effects

This section considers the potential adverse MC1-related effects on the Public Health and Safety VC arising from potential interactions, as identified in **Table 8.3-14** and in relation to the measurable parameters listed in **Table 8.3-15**. Mitigation measures for each potential effect are described in **Section 8.3.3.**

Health Effects from Changes in Air Quality

Option activities that would result in increased emissions to air may result in potential effects on human health for individuals located within the LAA. As described in **Section 6.1 Atmospheric Environment**, emissions of CACs were estimated for the year of highest activity during the Construction phase, specifically when the realignment of Highway 66 would likely overlap with the construction of all other MC1 components (i.e., worst-case emissions scenario).

Construction emission sources related to stripping, bulldozing, material handling, wind erosion from stockpiles, vehicles and equipment, re-entrained road dust, and Highway 66 realignment were considered. Emissions of CACs during the Operation and Maintenance phase of the Option were assumed to be low (negligible) compared to the Construction phase; therefore, the assessment of effects from emissions on air quality was limited to the Construction phase.

As described in **Section 6.1 Atmospheric Environment**, emission estimates were determined using MC1-specific information and information from the Site C Clean Energy Project EIS (BC Hydro 2013), which were adjusted to reflect the MC1 Option. Located on the Peace River in northeast British Columbia, the Site C Clean Energy Project involves construction of a dam site with associated activities at borrow sources and, in the absence of MC1-specific air quality modelling, provides a framework for estimating air emissions anticipated as a result of the MC1 Option.

Building on the dispersion modelling results from the Site C Clean Energy Project (BC Hydro 2013), dispersion modelling results were extrapolated for the MC1 Option to estimate ground-level air concentrations for the year of worst-case construction emissions. Further details and a discussion of the limitations associated with this approach are provided in **Section 6.1 Atmospheric Environment**. The predicted ground-level air concentrations of CACs resulting from the highest construction emissions scenario were added to ambient air concentrations to estimate approximate total exposure concentrations. The exposure concentrations for CACs at the air quality receptor locations are summarized in **Table 8.3-15**.

Table 8.3-15 Predicted Total Exposure Concentrations at Air Quality Receptor Locations

Receptor Location (distance from emission source)	Predicted Total Exposure Concentrations (ambient plus construction) (µg/m^3)						
	PM2.5		NO2		SO2		CO
	24-hour	Annual	1-hour	Annual	1-hour	Annual	1-hour
Ambient air concentration	10	3.7	2.8	0.8	10	1	0
Guideline	27	8.8	188	40	183	13	15,000
AQ1 (0.5 km) Proposed construction camp	25	<7	**200**	18	<15	1	350
AQ2 (0.4 km) Mclean Creek Campground	**45**	<7	**300**	23	<15	1	900
AQ3 (0.3 km) Easter Seals Camp Horizon	**>95**	<7	**>300**	>25	<15	2	1020
AQ4 (2.2 km) Gooseberry Campground/Elbow Valley Visitor Info Centre	<20	<7	<150	<13	<15	1	<270
AQ5 (0.4 km) Paddy's Flat Campground	**60**	<7	**300**	24	15	1	600
AQ6 (1.3 km) Station Flats Day Use Area	<20	<7	<150	<13	<15	1	<270
AQ7 (4.3 km) West Bragg Creek Day Use Area	<20	<7	<150	<13	<15	1	<270
AQ8 (1.5 km) Closest Bragg Creek residence (Highlands)	<20	<7	175	<13	<15	1	<270
AQ9 (3.8 km) Rural residence	<20	<7	<150	<13	<15	1	<270
AQ10 (4.7 km) Rural residence	<20	<7	<150	<13	<15	1	<270

Bold: exceeds guideline

As indicated by the results presented in **Table 8.3-15**, the predicted total 24-hour average concentrations for $PM_{2.5}$ during the worst-case construction year would exceed the CAAQS at several nearby AQ receptor points, including AQ2 (McLean Creek campground), AQ3 (Easter Seals Camp Horizon), and AQ5 (Paddy's Flat campground). Predicted short-term concentrations for NO_2 (1-hour) would exceed the inhalation exposure limit at AQ1 (the proposed construction camp), AQ2 (McLean Creek campground), AQ3 (Easter Seals Camp Horizon), and AQ5 (Paddy's Flat campground). All of these receptor locations are within 400 m of the source of construction emissions. The predicted short-term (1-hour) concentrations for SO_2 and CO and the predicted long-term (annual average) air concentrations for all CAC evaluated would be below inhalation exposure limits at all of the AQ receptor locations considered.

Acute NO_2 concentrations predicted for AQ1 (proposed construction camp) are not a specific concern to the public since use of this location during the Construction phase would be restricted to workers. However, short-term $PM_{2.5}$ and NO_2 concentrations are predicted to exceed guidelines at the AQ2 (McLean Creek campground), AQ3 (Easter Seals Camp Horizon), and AQ5 (Paddy's Flat campground), where members of the public, including those who are particularly sensitive to air pollution (i.e., children and the elderly), may be exposed and experience adverse health effects.

Numerous epidemiological studies conducted in the US, Canada, Britain, and Europe indicate an association between increased ambient 24-hour $PM_{2.5}$ concentrations and increased population mortality and morbidity, particularly related to cardiovascular and respiratory effects in children and the elderly (Health Canada 2006; US EPA 2009). Regulatory agencies have recognized that actions for continued reduction of ambient $PM_{2.5}$ concentrations are beneficial to human health since a threshold concentration below which adverse effects do not occur has not been identified (CCME 2012, WHO 2006). This is reflected in the continuous reduction of $PM_{2.5}$ standards since a Canada-wide standard for $PM_{2.5}$ was first introduced in 2000 (CCME 2000; 2012).

Similarly, recent studies have suggested there may be no threshold between acute (1-hour) exposure to NO_2 and respiratory morbidity, specifically emergency department visits for children with asthma (US EPA 2016). Individual response to chemical exposure varies (e.g., genetic differences, pre-existing disease conditions, etc.), and data characterizing health effects at low NO_2 exposure concentrations are particularly limited (US EPA 2016).

The chemical composition and toxic effects of $PM_{2.5}$ from different emission sources can vary widely, and have been the focus of recent research, with studies indicating that $PM_{2.5}$ from vehicle emissions and biomass burning have a higher oxidative potential, which is associated with systemic and respiratory inflammation, DNA damage, emergency department visits for congestive heart failure, and asthma and wheezing attacks (Weichenthal et al. 2016; Weber et al. 2015). Long-term exposures to $PM_{2.5}$ from fuel oil combustion and power plant emissions were shown to have the highest effect on mortality in older adults (over 65 years) from 81 cities in the United States of America (USA) between the years 2000 and 2010, while null or adverse associations with mortality were determined for $PM_{2.5}$ with high concentrations of crustal and oceanic particles (Kioumourtzoglou et al. 2015).

The realignment of Highway 66 would be the dominant source of $PM_{2.5}$ emissions and NO_x emissions associated with the construction of MC1. Highway realignment includes transporting and handling aggregate materials for asphalt production, operating a mobile asphalt batch plant, grading, and paving. When compared to highway realignment, the emissions of $PM_{2.5}$ and NO_x estimated from all other construction activities combined are much lower (**Section 6.1 Atmospheric Environment, Table 6.1-16).**

For this assessment, the predicted ninety-eighth percentile ground-level $PM_{2.5}$ and maximum NO_2 concentrations over one year of construction were compared to CAAQS or United States Environmental Protection Agency standards, which recognize achievement of standards based on three-year averages of the annual ninety-eighth percentile of daily ($PM_{2.5}$) or 1-hour (NO_2) concentrations. The scenario under assessment is therefore relatively conservative since it is based on a single year of worst-case emissions data, and it is likely that concentrations averaged over three years would be lower considering the reduction in emissions before and after the worst-case construction year. However, considering that thresholds have not been identified for the adverse health effects associated with acute exposure $PM_{2.5}$ or NO_2, it would be prudent to mitigate these emissions during construction or avoid situations where acute exposure to concentrations of $PM_{2.5}$ and NO_2 above recommended guidelines may occur.

Based on the information available, there would be the potential for adverse health effects for members of the public within 400 m of construction emissions where 1-hour NO_2 and 24-hour $PM_{2.5}$ concentrations exceed recommended exposure limits (i.e., McLean Creek campground, Easter Seals Camp Horizon, and Paddy's Flat campground). When compared to the recommended guideline for NO_2, the maximum predicted 1-hour NO_2 concentrations were greater than 1.6 times higher at Easter Seals Camp Horizon and 1.6 times higher at Paddy's Flat campground and McLean Creek campground. When compared to the recommended guideline for $PM_{2.5}$, the predicted ninety-eighth percentile 24- hour $PM_{2.5}$ exposure concentrations were greater than 3.8 times higher at Easter Seals Camp Horizon, 2.4 times higher at Paddy's Flat campground, and 1.8 times higher at McLean Creek campground.

The emissions and ground-level air concentrations for the MC1 Operation and Maintenance phase were not assessed in **Section 6.1 Atmospheric Environment** since they would likely be minimal compared to the Construction-phase worst-case scenario. In the event of a flood and after flood waters have receded in the reservoir, wind erosion of reservoir banks would generate dust and result in short-term increases in ground-level $PM_{2.5}$ concentrations within the LAA for Air Quality. These conditions are unlikely to persist such that the three-year average of the annual ninety-eighth percentile of daily $PM_{2.5}$ concentrations would exceed the CAAQS. Furthermore, the $PM_{2.5}$ generated by these conditions (i.e., crustal sources) would have relatively low toxicity compared to $PM_{2.5}$ generated from combustion processes, as described above.

Health Effects from Changes in Noise Levels

Option activities that produce noise may result in potential effects on human health for individuals located within the LAA. Activities occurring during the Construction phase are assumed to represent the worst-case scenario in terms of MC1-related noise sources and sound power levels. The noise levels during the Operation and Maintenance phase of the MC1 Option have not been predicted as they are assumed to be low (negligible) compared to noise levels during the Construction phase.

Sources of noise during MC1's Construction phase include use of heavy equipment such as backhoes, shovels, dozers, loaders, and haul trucks. As described in **Section 6.1 Atmospheric Environment**, in the absence of detailed MC1-specific information on construction equipment, noise sources for the MC1 Option were estimated using data from the Site C Clean Energy Project (BC Hydro 2013).

Receptor locations, designated highway noise receptors (HNRs), are located along the highway realignment route. The potential change in noise levels at these receptor locations were analyzed separately from locations near the main construction area since the noise levels predicted for these locations would likely be short term (approximately 2 months). An exception is HNR3 (Paddy's Flat campground), which is located near the proposed highway bridge and would require over two months but less than one year to construct.

The predicted total (existing plus MC1 construction) noise levels for HNR receptor locations are described in detail in **Section 6.1 Atmospheric Environment** and summarized below in **Table 8.3-16**.

Table 8.3-16 Predicted Noise Levels along the Highway Realignment Route

Receptor Location	Existing Plus Option Construction Noise Scenario		
	Day, Ld (dBA)	Night, Ln (dBA)	Ldn (dBA)
HNR1 - McLean Creek Campground	49.6	**45.5**	52.8
HNR2 – Building in Mclean Creek PLUZ	46.3	**41.7**	49.1
HNR3 - Paddy's Flat Campground	45.9	**40.3**	48.1
HNR4 - Gooseberry Campground	53.3	**45.4**	54.2

Note: Bold - exceeds guideline

Three of the HNR locations are campgrounds where members of the public may be affected by higher noise levels at night (i.e., HNR1 (McLean Creek campground), HNR3 (Paddy's Flat campground), and HNR4 (Gooseberry campground)). The camping season is year-round at HNR1 (McLean Creek Campground) and between May and September at HNR3 (Paddy's Flat) and HNR4 (Gooseberry)(Alberta Parks 2017c). Overnight camping is not anticipated at HNR2, which is situated in an area of active off-highway vehicle use in the McLean Creek PLUZ.

The predicted normalized outdoor day-night sound levels at all HNR locations are below the Health Canada (2016) threshold for adverse health effects (i.e., Ldn = 55 dBA). However, night sound levels are predicted to slightly exceed the WHO annual average threshold for sleep disturbance effects (i.e., Ln = 40 dBA) at the Paddy's Flat campground (i.e., Ln = 40.3 dBA) with higher night time noises predicted at the Gooseberry and McLean Creek campgrounds (i.e., Ln = ~45 dBA).

Sleep disturbance effects may include increased fatigue, irritability, decreased concentration, and performance. Chronic sleep disturbance can lead to cardiovascular effects and effects on mental health (WHO 2009). It is important to note that the WHO guideline is based on yearly average noise levels, whereas the noise predictions in **Table 8.3-16** are expected to last less than one year, two months in most cases. Furthermore, camping in Alberta Parks is restricted to a maximum 16-night stay limit (Alberta Parks 2017c), which further reduces the potential for chronic exposure to night time noise.

Public exposure to night time noise at camping locations along the highway realignment route depends on whether public access to these campgrounds would be allowed during highway realignment activities. Acute sleep disturbance may occur while camping at these locations during the Construction phase; however, acute sleep disturbances are not associated with adverse health effects.

The predicted total (existing plus MC1) noise levels and LFN analysis for public receptor locations near the main construction area are provided in **Table 8.3-17**.

Table 8.3-17 Predicted Noise Levels at Public Receptor Locations

Receptor Location	Baseline plus Option Construction Noise Scenario				LFN Analysis	
	Day, Ld (dBA)	Night, Ln (dBA)	Ldn (dBA)	%HA	Daytime dBC – dBA (dB)	Nightime dBC – dBA (dB)
NR1 – Easter Seals Camp Horizon	50.2	**41.5**	50.7	2.2	3.7	3.1
NR2 - Construction Camp / McLean Creek Campground	45.7	39.2	47.4	1.4	3.4	2.9
NR3 – McLean Creek Campground	48.2	39.5	48.7	1.7	3.6	2.6
NR4 – Station Flats Day Use Area	45.0	35.2	45.1	1.0	3.3	2.8
NR5 - Closest Bragg Creek residence (Highlands)	48.0	38.2	48.1	1.6	3.6	2.6
NR6 – Rural residence	45.0	35.2	45.1	1.5	3.3	2.6
NR7 - Rural residence	45.0	35.2	45.1	1.0	`3.3	2.6

Note: Bold - exceeds guideline

The night sound levels predicted at most public receptor locations near the main construction area are below the WHO threshold for sleep disturbance effects (i.e., Ln = 40 dBA), except for NR1 (Easter Seals Camp Horizon) which slightly exceeds this threshold (i.e., Ln = 41.5 dBA). Again, the WHO guideline is based on continuous chronic exposure. The camp is not a residence and, although there is use throughout the year, it is not occupied on a continuous basis; therefore, individual campers or counsellors are unlikely

to suffer from chronic sleep disturbance or the health effects associated with chronic sleep disturbance at this location.

The Ldn predictions were below the Health Canada (2016) “no adverse health effect” level (i.e., Ldn less than 55 dB) and %HA predictions were below the threshold for chronic high annoyance (i.e., less than 6.5%HA). The differences between C- and A-weighted sound predictions were less than 10 dB at each receptor location; therefore, LFN would not likely result in increased annoyance.

Although no formal predictions of noise were determined for the Operation and Maintenance phase of the MC1 Option, noise levels would likely be much lower than during the Construction phase. No substantive health effects are predicted due to changes in noise levels during the MC1’s Construction phase and, by extension, during the Operation and Maintenance phase.

Health Effects Related to Drinking Water Quality

Health effects could result from changes in groundwater or surface water used as drinking water sources. The potential effects of the MC1 Option on groundwater quality are described in detail in **Section 6.3 Hydrogeology**. The removal of borrow material above an alluvial aquifer could increase susceptibility to contamination from the surface. Domestic use wells (i.e., drinking water) are primarily developed in bedrock aquifers (**Section 6.3 Hydrogeology**) and are therefore unlikely to be affected by the changes in groundwater quality in the alluvial aquifer.

Groundwater supply wells within the proposed reservoir site are located in surficial and bedrock aquifers and would require proper decommissioning to prevent groundwater contamination during the Operation and Maintenance phase. These include one well in the east EVRS and two wells in the west EVRS. The decommissioning of the EVRS would include remediation of existing soil contamination, including PAH in the west EVRS, which would reduce manganese concentrations in groundwater (currently above drinking water guidelines).

Although surface water would undergo water treatment prior to human consumption, the maintenance of surface water quality is vital to public health. The potential effects of the MC1 Option on surface water quality are described in detail in **Section 6.5 Water Quality**. The Elbow River is naturally turbid during high flows (spring and summer), and this turbidity may be increased by activities during the Construction and Operation and Maintenance phases. High turbidity could introduce total organic carbon into downstream water distribution systems which may combine with chlorinated disinfection chemicals to form toxic disinfection by-products (DBPs) in drinking water (e.g., trihalomethanes) (Li 2014). DBPs are monitored when a water source is being treated for drinking water.

The mishandling of materials such as fuels, lubricants, cementitious materials, nitrogen from blast residues, and anti-freeze during MC1 construction activities would result in surface water contamination (see **Section 11.0 Accidents and Malfunctions**). During the Operation and Maintenance phase, flooding of the land to form the permanent pond could introduce soil contaminants and increase organic matter content in surface water. Nutrient loading in the reservoir and permanent pond may increase algal biomass, including potentially toxic taxa of cyanobacteria. The introduction of fecal coliforms to surface water is also a concern, since flooding of septic fields near the EVRS is required to establish the permanent pond.

Effects on Regional Health Services

Construction of the Option would not likely bring in new residents to the community as the majority of construction workers are considered likely to either commute from the Calgary area, or may choose to live in the proposed work camp (see **Section 8.2 Socio-economic Resources**). During the Construction phase, workers may require periodic access to health services while spending time in the LAA. This increase in demand would potentially be an adverse effect for the community of Bragg Creek, which has limited health services; however, within the Calgary zone, AHS provides health services for a population of 1,371,401 (AHS 2011) which could accommodate MC1 construction workers. No adverse effects are likely for regional health services as a result of MC1 construction since no new residents are anticipated in the region and AHS could accommodate MC1 construction workers.

The health benefits of flood reduction are numerous and include the prevention of the direct and indirect health effects associated with floods, including fatality from drowning, injury caused by flood debris, disease/infections associated with flood waters, and mental health effects associated with infrastructure damage and population displacement and disruption. The MC1 Option would have a positive effect on regional health services as a result of flood reduction. The indirect effects of floods on mental health do not appear for months or years after the event and are difficult to quantify, it is assumed the Option would also yield benefits in terms of reduced demand on mental health and related community services.

Public Safety

Several aspects of MC1 construction activities could affect the safety of the public. For example, construction would require realignment of Highway 66, which could affect the safety of highway users during that period. A flood event during the Construction phase could result in failure of partially constructed infrastructure (cofferdam) and release debris into the Elbow River and result in public safety risks associated with damaged infrastructure, including roads, highways, and trails. Recreational use of the permanent pond may require management to protect public safety during MC1 operation and management. The MC1 Option would have a positive effect on public safety as a result of flood reduction.

Emergency Preparedness and Response

Removal of the EVRS during MC1 construction would affect emergency response in the region as this station currently serves as the base of operations during emergency events, including wildfire suppression, wildlife management, and rescue in the summer. The Option would have a positive effect on emergency preparedness and response in terms of flood reduction.

8.3.3.3 Mitigation Measures

Mitigation measures comprise any practical means taken to manage potential adverse effects, and may include applicable standards, guidelines, and best management practices (BMPs) supported by specific guidance documents. Mitigation measures to address potential adverse effects are described below and summarized in **Table 8.3-18.** The final column in the table identifies whether or not there is the potential for a residual effect. In accordance with Alberta Transportation standard practice, BMPs and standard mitigation measures would be included in the Environmental Construction Operations (ECO) Plan Framework that would be developed by the contractor and reviewed by Alberta Transportation prior to the start of construction.

Mitigation Measures Identified for Air Quality Valued Component

During the worst-case year of construction, short-term $PM_{2.5}$ (24-hour) and NO_2 (1-hour) concentrations would likely exceed recommended health-based guidelines within 400 m of dam and reservoir construction activities. Although not specifically evaluated, dust emissions from wind erosion of reservoir banks after a flood could result in localized increases in 24-hour $PM_{2.5}$ air concentrations during the Operation and Maintenance phase.

The mitigation measures to control peaks in short-term $PM_{2.5}$ and NO_2 concentrations during the Construction phase (described in detail in **Section 6.1 Atmospheric Environment)** would also be effective in mitigating potential risks to public health. The generation of $PM_{2.5}$ emissions would be mitigated through fugitive dust mitigation measures and management of open burning practices. Emissions of NO_2 would be mitigated though regular inspection of vehicles and equipment, selection of a mobile asphalt plant that meets or exceeds Alberta's emission limits, and BMPs.

These mitigation measures would be effective at providing some level of reduction in predicted short-term $PM_{2.5}$ and NO_2 concentrations during the MC1 Construction phase, and would likely be sufficient to bring down the slight exceedance of NO_2 concentrations at the location of the proposed construction camp (AQ1). However, the higher short-term $PM_{2.5}$ and NO_2 air concentrations predicted for recreational sites located near the construction zone (AQ2, AQ3 and AQ5) would likely remain above health-based guidelines.

The generation of $PM_{2.5}$ from wind erosion after a flood could be mitigated through the application of mitigation measures (i.e., clearing of loose sediment on reservoir banks) as proposed in **Section 6.1 Atmospheric Environment**. The higher $PM_{2.5}$ concentrations associated with these events are not expected to result in adverse health effects since the $PM_{2.5}$ generated under these conditions (i.e., crustal sources) would have relatively low toxicity compared to $PM_{2.5}$ generated from combustion processes (i.e., construction emissions). Also, these conditions are unlikely to persist such that the three-year average of the annual ninety-eighth percentile of daily $PM_{2.5}$ concentrations would exceed the CAAQS.

Mitigation Measures Identified for Drinking Water

The mitigation measures to control potential effects on alluvial groundwater (described in detail in **Section 6.3 Hydrogeology)** would also be effective in mitigating potential risks to public health due to potential changes to groundwater that may be used as a source of drinking water. During the Construction phase, these measures would include development of BMPs for spill management, as well as soil salvage, reclamation, and revegetation measures. During the Operation and Maintenance phase, the decommissioning of water supply wells within the Option footprint would be conducted under supervision of a Qualified Professional and would follow Alberta Regulation 205/1998 (Section 66). These measures would mitigate potential adverse effects of the Option on local groundwater quality during MC1 construction, operation, and maintenance, thereby protecting this drinking water source.

Mitigation measures to control potential effects on surface water quality (described in detail in **Section 6.5 Water Quality)** would also be effective in mitigating potential risks to public health due to potential changes to surface water that may be used as a source of drinking water. The potential effects of MC1 construction activities would be mitigated by the application of BMPs, including development and implementation of an Erosion and Sediment Control Plan to control the release of organic matter into the Elbow River and permanent pond. Blast management measures would be developed to control the introduction of sediment and chemicals to the Elbow River from explosive use. The risk of increased turbidity and chemical contamination associated with cement use would be managed through cementitious materials management measures. Chemical contaminant measures would be developed to manage chemicals associated with construction. Wastewater containment measures would be developed to contain prevent excessive algal growth in the Elbow River and permanent pond from the release of nutrients in wastewater. Contaminated soils containment measures would be developed to manage the release of contaminated soil from septic fields and around the EVRS and park infrastructure These mitigation measures would mitigate potential adverse effects of MC1 construction activities on local groundwater quality and protect this drinking water source.

Mitigation measures during the Operation and Maintenance phase would include vegetation management measures to prevent or limit nutrient release, trophic upsurge, and depression, and reduce the potential for methylmercury formation within and downstream of the permanent pond affecting drinking water quality

downstream of the dam. Permanent Pond operation measures would be established to control nutrient loading, algal growth, and water temperature. In addition, reclamation and revegetation measures would be developed to rehabilitate aquatic habitat following completion of the dam to reduce harmful effects of the Option on surface water quality. Filtration and disinfection would be ensured in downstream water distribution systems.

These proposed mitigation measures are considered largely sufficient for the protection of surface water quality during the Operation and Maintenance phase.

Public Access Restrictions

The potential health risks associated with acute inhalation exposure to $PM_{2.5}$ and NO_2 would be managed by closing public access to recreational sites within 400 m of construction emissions during the first year of construction (i.e., McLean Creek campground, Easter Seals Camp Horizon, and Paddy's Flat campground). This mitigation measure would be effective at eliminating human exposure to $PM_{2.5}$ and NO_2 concentrations that are above health-based guidelines during construction and prevent any associated adverse health effects.

Public access to the EVRS area would be restricted while remedial activities are being conducted and prior to establishing the permanent pond. This mitigation would be effective for the protection of public safety during construction.

Signage advising against water consumption would be posted around the permanent pond. Permanent fencing or warning buoys would be placed around facilities or features that direct or handle water. These mitigation measures would protect the public from potential health effects from the direct consumption of surface water and safety effects associated with potential recreational use of the permanent pond.

Traffic Accommodation Strategy

Public safety risks during realignment of Highway 66 would be mitigated by the design and implementation of a Traffic Accommodation Strategy, which would be developed in accordance with Alberta Transportation Traffic Control Standards and would adhere to Alberta Transportation (2008) guidelines. This mitigation would protect against potential public safety effects associated with highway realignment.

Alternate Base for Regional Emergency Response Services

The EVRS currently serves as a base of operations during emergency events, including wildlife management and rescue in the summer. During the Construction phase, another base of operations would be identified for these regional services while the ranger station is relocated. This mitigation would protect against potential public safety effects associated with emergency events not related to MC1.

Emergency Preparedness and Emergency Response Measures

Development and implementation of emergency preparedness and emergency response measures would mitigate potential effects to public safety during the Construction and Operation and Maintenance phases. The emergency preparedness measures would be developed in accordance with relevant guidelines, and the coordinating body for the initial response to a natural or human-induced disaster (i.e., Provincial Operations Centre) would be consulted during the development of all emergency preparedness and response measures. would. These measures would describe potential emergency scenarios and effects; outline training requirements for personnel involved with all aspects of MC1 work; and provide notification procedures for emergency response agencies and stakeholders, including contact details and direction for personnel, methods of communication, etc. The emergency response measures would be developed in conjunction with the emergency preparedness measures, and would outline roles and responsibilities for individuals and agencies. The measures would also include the planned steps to activate the emergency response procedures, including communication with the public. The development of emergency preparedness and emergency response measures and application of BMPs is considered effective mitigation for minimizing potential effects on emergency preparedness and response.

The measures would outline specific actions including training requirements, notification and communication plans, emergency response agencies, and stakeholder and individual roles and requirements during emergencies scenarios. A potential scenario during construction would be failure of partially constructed infrastructure during the program, which could introduce unplanned debris to the watershed or unplanned flow paths during flood events. These measures would protect public safety during emergency events related to MC1.

Flood Water Retention

The Option is intended to improve overall public safety and emergency preparedness and emergency response during flood conditions. Flood water retention would likely result in numerous benefits for health and regional health services that would be realized before, during, and after a flood event. This effect of the Operation and Maintenance phase would be positive in terms of public health and safety and emergency preparedness and emergency response.

Table 8.3-18 Summary of Potential Effects and Mitigation Measures for Public Health and Safety

Potential Effect	Option Components	Contributing Option Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Construction Phase				
Exceedance of $PM_{2.5}$ and NO_2 short-term inhalation guidelines	Permanent pond and reservoir Earth fill dam Borrow and spoil areas Highway 66 relocation Site clearing	Bulldozing Use of non-road construction equipment Transport of construction materials along Highway 66 and site access roads Operation of mobile asphalt plant Burning of debris generated from site clearing	Mitigation measures identified for Air Quality VC (fugitive dust management measures, management of open burning, regular inspection of vehicles and equipment, selection of a mobile asphalt plant that meets or exceeds Alberta's emission limits, and BMPs) Public access restrictions	No
Health effects related to drinking water quality	All disturbed areas	Excavation of aquifer materials Fuel spills Waste storage/disposal Construction of the dam, cofferdam, road and road access points, new bridge, material storage, borrow sites and upland work areas Blasting Decommissioning of EVRS Flood during construction Heavy equipment operation Permanent pond development	Mitigation measures for Groundwater Quality VC (BMPs for spill management, soil salvage measures, reclamation and revegetation measures) Mitigation measures for Water Quality VC (Erosion and Sediment Control Plan, blast management measures, cementitious materials management measures, chemical contaminant measures, wastewater containment measures, and contaminated soil containment measures) Public access restrictions	No
Public Safety	All disturbed areas; including Highway 66 relocation	Remedial activities Excavation and soil transport. Ranger station decommissioning Infrastructure construction	Public access restrictions Traffic Accommodation Strategy Development and implementation of emergency preparedness and emergency response measures	No
Emergency preparedness and response	All disturbed areas; including Highway 66 relocation	Ranger station decommissioning	Alternate base for regional emergency response services Development and implementation of emergency preparedness and emergency response measures	No

Potential Effect	Option Components	Contributing Option Activities	Proposed Mitigation Measure	Detectable / Measurable Residual Effect
Operations and Maintenance Phase				
$PM_{2.5}$ concentrations potentially above short-term inhalation guideline	Flood storage reservoir	Wind erosion of reservoir banks	Mitigation measure for Air Quality VC (clearing loose sediment on reservoir banks)	No
Health effects related to drinking water quality	Permanent pond	Flooding of land, including septic fields, to form the permanent pond Water residence time in reservoir Inundated soil and vegetation around the permanent pond	Mitigation measure for Groundwater Quality VC (decommissioning all water wells in probably maximum flood footprint) Mitigation measure for Water Quality VC (vegetation management measures, permanent pond operation measures, and reclamation and revegetation measures) Public access restrictions	No
Risks to public safety from recreational use and incidental water consumption	Permanent pond	Storage of water in permanent pond	Signage to warn against surface water consumption Warning buoys around facilities or features that direct or handle water Public access restrictions	No
Public health and safety and emergency preparedness/ response	Probable maximum flood footprint	Flood operations	Flood water retention	Yes

8.3.3.4 Residual Effects

Residual effects are MC1-related effects that would likely occur to VCs after the application of mitigation measures. This section describes how the residual effects of the MC1 Option are characterized and summarized for Public Health and Safety. The determination of a substantive or non-substantive residual effect includes a characterization including magnitude, regional extent, and duration.

Residual Effects Characteristics

Residual effects in the context of the Public Health and Safety are characterized based on the criteria defined in **Table 8.3-19**.

Table 8.3-19 Residual Effects Characteristics for Public Health and Safety

Residual Effect Characteristic	Rating	Definition
Direction	Positive	Net benefit to public health and safety
	Adverse	Net loss to public health and safety
Extent	Local	Confined to the area directly disturbed by Option footprint
	Sub-regional	Limited to the LAA
	Regional	Within the RAA
Magnitude	Negligible	No change in public health and safety
	Minor	Minor increase in public health and safety
	Moderate	Moderate increase in public health and safety
	Major	Major increase in public health and safety
Duration	Short-term	Effect would not persist beyond MC1 Construction phase
	Long-term	Effect lasts for the entire life of the Option or beyond
Reversibility	Reversible	Effect could be reversed once the activity causing the residual effect ceases
	Not reversible	Effect is permanent
Frequency	Isolated	Effect would likely occur once
	Rare	Effect would be episodic (e.g. flood event)
	Frequent	Effect would occur more than 50% of the time
Confidence	High	Rating predictions are based on a good understanding of cause-effect relationships and/or using data specific to the Option area
	Moderate	Rating predictions are based on a good understanding of cause-effect relationships relying on data from elsewhere, or incomplete understanding of cause-effect relationships from data specific to MC1
	Low	Rating predictions are based on an incomplete understanding of cause-effect relationships and incomplete data

Public Health and Safety and Emergency Preparedness and Response during a Flood Event

The operation and maintenance of MC1 would improve overall public health and safety, as well as emergency preparedness and emergency response during flood conditions. This residual effect of the Operation and Maintenance phase is considered to be positive. The residual effect characteristics ratings for the Public Health and Safety VC during the Operation and Maintenance phase of MC1 are provided in **Table 8.3-20**.

Table 8.3-20 Summary of Effect Characteristics Ratings for Public Health and Safety during Option Operation and Maintenance

Residual Effect Characteristic	Rating	Rationale for Rating
Direction	Positive	Benefit to public health and safety emergency preparedness/emergency response
Extent	Regional	Effect extends to susceptible populations located downstream of the Option, including Bragg Creek, Redwood Meadows, Tsuut'ina Nation and Calgary
Magnitude	Major	Benefit would result increase public health and safety and improve emergency preparedness/emergency response
Duration	Long-term	Benefits would last the life of the Option
Reversibility	Not reversible	Not reversible during the life of the Option
Frequency	Rare	Benefit would be intermittent in accordance with flood risks
Confidence	High	Health and safety benefits of flood reduction are well understood

8.3.3.5 Summary of Public Health and Safety Assessment

Based on the effects characterization for the residual effect listed in **Table 8.3-20** and **Table 8.3-19**, there are likely to be no adverse residual effects on Public Health and Safety associated with changes in air quality or surface water quality conditions, or emergency preparedness and response assuming best practices and mitigation measures are followed.

There would likely be a positive substantive residual effect on Public Health and Safety due to improvements in overall public health and safety as well as emergency preparedness and emergency response during flood conditions (i.e., flood risk reduction).

8.3.4 FOLLOW-UP MONITORING FOR PUBLIC HEALTH AND SAFETY

Follow-up monitoring of air quality has been recommended to protect public health and safety if the MC1 option were to proceed through formal regulatory approvals. As described in **Section 6.1 Atmospheric Environment**, open burning of wood debris generated from site clearing were not considered in the estimation of CAC concentrations during the Construction phase and may result in higher CAC concentrations at locations beyond the recreational sites identified in this assessment. An air quality monitoring program to continuously monitor $PM_{2.5}$ concentrations at permanent residences during the Construction phase is therefore recommended. A monitor would be installed in the Highlands neighbourhood of Bragg Creek near the location of AQ7. In addition, metrological conditions would be monitored during the Construction phase to provide forecasts that would enable adjustment of construction activities to minimize dust emissions.

Follow-up monitoring of water quality has been recommended to protect human health. As described in **Section 6.5 Water Quality**, surface water quality would be monitored to verify the accuracy of residual effects predictions and efficacy of mitigation measures and confirm compliance with drinking water guidelines for the protection of human health. Water quality parameters would be monitored at one station in the permanent pond (i.e., dissolved organic matter, temperature, turbidity, algal biomass and nutrient concentrations, fecal coliforms) and at one station downstream of the dam (fecal coliforms).

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9.0 PLANNED DEVELOPMENT CASE

This section describes the Planned Development Case, or the environmental conditions that may occur as a result of the interaction of the Elbow River at McLean Creek Dam (MC1) Option with other existing and planned projects and activities that can be reasonably expected to occur.

The Planned Development Case is evaluated through the completion of a cumulative effects assessment (CEA) (AEP 2013), which examines how substantive adverse residual effects of the Option may interact, spatially and temporally, with the residual effects of other past, present, or future projects. This CEA has been informed by methodology and practices defined by the Canadian Environmental Assessment Agency (CEA Agency 2014) and Hegmann et al. (1999), with modifications made to reflect the screening-level nature of this assessment. These modifications are described below.

The CEA has been conducted with a focus on substantive adverse residual effects. Environmental assessment best practice suggests that all residual effects remaining after the implementation of mitigation measures are considered in a CEA; however, due to the screening level assessment conducted for this Report, it has been determined that a CEA for all residual effects (i.e., non-substantive and substantive) would not result in meaningful conclusions for some disciplines. Similarly, only interactions that could result in a potentially substantive cumulative adverse effect are identified.

Cumulative effects have been assessed through the following steps:

1. Identify substantive MC1-related adverse residual effects for consideration in the CEA.

2. Identify past, existing, and reasonably foreseeable projects and activities that may interact in a cumulative manner with MC1 substantive adverse residual effects (i.e., the Project Inclusion List (PIL)). The spatial boundaries applied for evaluation of each substantive adverse residual effect corresponds to the Regional Assessment Area defined for each Valued Component (VC).

3. Determine potential MC1-related adverse effects that would interact cumulatively with the residual effects of the identified projects and activities.

4. Describe suitable mitigation measures to address the cumulative effects.

5. Determine substantive adverse residual cumulative effects that may remain, following application of mitigation, and the contribution of the Option to these effects, if any. Identify substantive residual cumulative effects are characterized using the same residual effects assessment criteria identified in the respective VC section.

9.1 SUBSTANTIVE ADVERSE RESIDUAL EFFECTS

Substantive adverse residual effects associated with the MC1 Option considered in this CEA include the following:

- Fluvial Geomorphology: changes to channel morphology
- Vegetation and Wetlands: reduction in biodiversity due to loss of tracked plant species
- Wetlands: reduction in wetland area and function
- Fish and Fish Habitat: increased risk of fish mortality and reduced productivity for bull trout
- Land and Resource Use: reduction to recreational use.

9.2 PROJECT INCLUSION LIST

The Project Inclusion List was developed from publicly available government data for past, existing, and reasonably foreseeable projects and activities within the largest relevant RAA, the Aquatics Resources RAA, which encompasses the entire Elbow River watershed, downstream to the inlet at the Glenmore Reservoir. This RAA is sufficient to identify projects and activities that may interact with all MC1-related substantive residual adverse effects.

Table 9.2-1 lists the types of projects and activities that were identified in the Aquatics Resources RAA, which may interact with MC1 substantive adverse residual effects. Within this RAA the following table of existing and future projects, activities, and potential effects were identified as potentially having a spatial and temporal overlap of substantive adverse residual effects.

Table 9.2-1 Project Inclusion List[1]

Project Name [2]
Rocky View County Trail Remediation (1 project)
Southwest Calgary Ring Road Project (1 project)
Oil and Gas Battery and Compressor Stations (21 data points)
Oil and Gas Well Sites (104 active, abandoned, suspended data points)
Oil and Gas Pipelines (304 abandoned, discontinued, active, or future line data)
Transmission Line (9 line data)
Gravel quarry (3 data files)
Administrative Plans
South Saskatchewan Regional Plan (and all the administrative boundaries within)
Kananaskis Improvement District
Bragg Creek Area Structure Plan
Municipal District of Foothills No. 31
The Kananaskis Country
Provincial Parks and Recreation Areas (Spray Valley, Peter Lougheed, Sheep River, Bow Valley, Fish Creek, and Glenbow Ranch)
McLean Creek Off-Highway Vehicle
Registered Fur Management Area Boundary
Forest Protection, Management, or Cut Block Area
Water Licenses
Licenses for the following purposes: Agricultural, Commercial, Construction and Transportation, Dewatering, Government Hold Back, Habitat Enhancement, Industrial, Irrigation, Management of Fish, Municipal, Recreation, and Water Management
Tenure Applications
Agricultural Land Sales or Grazing Leases
Timber Harvesting
Forest Cut Block Areas

Notes

[1] The Project Inclusion list is generated (August 2017) from overlapping foreseeable projects and activities that fall within the boundary of Aquatic Resources Regional Assessment Area.

[2] Springbank Off-Stream Reservoir Project is not included in the cumulative effects analysis because it is considered the primary alternative to the MC1 Option.

9.3 FLUVIAL GEOMORPHOLOGY

One substantive adverse residual effect to Fluvial Geomorphology was identified as a result of implementation of MC1: changes to channel morphology from changes in sediment transport downstream of MC1 as a result of the dam.

Since the Baseline Case for Fluvial Geomorphology considers the effects of other past and present projects, this Planned Development Case examines only the potential for interactions between the substantive adverse residual effect to changes in channel morphology resulting from MC1 and the incremental effects of future projects and activities that are certain and reasonably foreseeable.

A backcountry trail remediation project and the Southwest Calgary Ring Road (SWCRR) are the major projects identified in the Surface Water Regional Assessment Area (RAA). The trail remediation project is ongoing, and is expected to conclude in the spring of 2018; it was initiated in 2014 to remediate back-country multi-user trails in the Greater Bragg Creek area that were subject to extensive erosion and damage to bridges and amenities because of the June 2013 flood (SWCRR 2017). The SWCRR commenced construction in 2017, and is anticipated to be completed in 2021. With appropriate water crossing designs, these projects would be anticipated to have only a very localized effect on channel morphology (i.e., within the project footprints).

Several dozen linear developments (i.e., oil and gas pipelines or super pipes and transmission lines) occur within the Aquatic Environment RAA. Among the existing or planned pipelines existing within the RAA, more than 50 are identified as having associated watercourse crossings (i.e., pipeline crossings occurring beneath the bed of a watercourse). Where a new pipeline crossing of a watercourse is constructed, instream work may be necessary. Transmission line installation may result in temporary vehicle and equipment crossings. Instream activities may also be required when a pipeline crossing is either replaced or otherwise requires maintenance, or is selected for an integrity investigation. It is expected, however, that ongoing maintenance and new construction of pipelines will follow standardized practices to minimize any effects to channel morphology. Any residual effects to channel morphology from these projects would be local in extent.

Given the minimal or localized effects to channel morphology from the above-listed projects, it is unlikely that the residual effects from those projects would interact with that of MC1, and a substantive cumulative effect on channel morphology is not likely to occur.

9.4 VEGETATION AND WETLANDS

One substantive adverse residual effect to Vegetation and Wetlands was identified as a result of implementation of MC1: reduction in biodiversity due to loss of tracked plant species.

Several occurrences of rare (tracked) botanical species may be affected during construction and operation of the SWCRR project. The environmental assessment conducted for this project concluded that mitigation measures for these rare plant species would only result in a minor residual effect to rare plants (AMEC 2014). Thus, while it is possible that biodiversity within the Wetlands and Vegetation RAA would experience an adverse cumulative effect from the loss of tracked species, given the minor nature of the effect from the SWCRR project, it is unlikely that this cumulative effect would be substantive.

While it is possible that many of the other projects and activities occurring within the Vegetation and Wetlands RAA would directly or indirectly affect tracked plant species through mechanisms such as habitat loss and degradation and spread of invasive species, the location of tracked species with respect to other projects and activities is currently unknown. The *Alberta Conservation Information Management System* (Alberta Parks 2015) lists identified occurrences of tracked species, but many of the records contained in this database are dated (e.g., over 50 years old), and the current status of recorded occurrences is unknown. Thus, the uncertainty around the potential for cumulative interaction is high and any assessment of cumulative effects to tracked species would be speculative. Due to the high degree of uncertainty, this cumulative effect is not considered further in this assessment. If MC1 were to proceed through formal regulatory approvals, additional work would be required to identify and quantify a

9.5 WETLANDS

One substantive adverse residual effect to Wetlands was identified as a result of implementation of MC1: reduction in wetland area and function.

The SWCRR, which commenced construction in 2017 and is anticipated to be completed in 2021, will involve a crossing of the Elbow River upstream of the Glenmore Reservoir, and will directly and indirectly affect several wetlands though habitat loss and change in hydrologic flows. These affected wetlands and the crossing are located within the MC1 Vegetation and Wetlands RAA; however, given the relative distance between the MC1 Option and the SWCRR, and given that construction of SWCRR is likely to be finished prior to construction of MC1, no spatial or temporal overlap of the residual effects to wetlands is predicted, and a cumulative interaction is not identified.

Agricultural and grazing activities in the RAA may lead to loss of wetland function due to possible fertilizer and pesticide use in adjacent areas, as well cattle encroachment on wetland area. The extent and magnitude of these effects are unavailable and speculative in nature. Current nutrient loading in the Elbow River from upstream activities (such as grazing and fertilizer use) is quantified in the Water Quality section (**Section 6.5**), any effect that current conditions may have on affected wetlands has been included in the Baseline Case for the evaluation of Wetlands (**Section 7.1**). It is unlikely that future agricultural and grazing use would increase to an extent that would cause a substantive cumulative effect to wetlands.

9.6 AQUATIC ENVIRONMENT

One substantive adverse residual effect to Fish and Fish Habitat was identified as a result of implementation of MC1: increased risk of fish mortality and reduced productivity for bull trout.

The backcountry trail flood rehabilitation program exists within the MC1's Aquatic Environment RAA (Government of Alberta 2017b). In addition, the SWCRR project also occurs within MC1's Aquatic Environment RAA; bull trout spawning habitat was identified in the Elbow River upstream of the Glenmore Reservoir in the project's EIA (AMEC 2014). While effects to bull trout were not specifically considered within this EIA, all residual effects to fish and fish habitat were considered to be negligible or minor.

Construction on these projects should be completed in advance of the potential construction date for MC1; however, it is possible that influences from construction activities may interact with the substantive residual effects of MC1 on increased risk of fish mortality and reduced productivity for bull trout. The potential for bull trout mortality is a possible by-product of instream construction activities necessary for watercourse crossing or channel and bed remediation; however, this potential is considered limited given the presumed application of standard or site-specific mitigation measures as required under the Code of Practice for Watercourse Crossings (Government of Alberta 2012). These measures include site isolation for works within the watercourse, adherence to restricted activity periods, and completion of fish salvages within isolated areas prior to commencing instream works.

As a result of the limited potential for fish mortality to occur from both projects, no interaction between this project and the substantive residual effect associated with MC1 is likely to occur.

Several dozen linear developments (i.e., oil and gas pipelines or super pipes and transmission lines) are present within the Aquatic Environment RAA; among the existing or planned pipelines in the RAA, more than 50 are identified as having associated watercourse crossings (i.e., pipeline crossings occurring beneath the bed of a watercourse). In some cases, the status and condition of crossings are unchanged from the original construction period, while in others, crossings have been replaced at least once or are now abandoned (i.e., with the pipeline infrastructure either remaining in place and no longer conveying product material or having been removed altogether).

Where a new pipeline crossing of a watercourse is constructed, instream work may be necessary. Transmission line installation may result in temporary vehicle and equipment crossings. Instream activities may also be required when a pipeline crossing is either replaced or otherwise requires maintenance, or is selected for an integrity investigation. Where instream work is required, some potential exists for fish in the vicinity of the works to be affected; however, standards and conditions outlined in Alberta's *Code of Practice for Watercourse Crossings* (Government of Alberta 2012) and *Code of Practice for Pipeline and Telecommunication Lines Crossing a Waterbody* (Government of Alberta 2013) provide typical avoidance and mitigation strategies to limit the potential for harm to fish and aquatic habitat. When the standards and

conditions of these codes cannot be met, construction planning requires the written specifications of a Qualified Aquatics Environmental Specialist (QAES) to ensure the maintenance of the productive capacity (i.e., including fish health) of the aquatic environment. The application of these standard mitigation measures (or site-specific measures provided by a QAES), is expected to substantially reduce the potential for fish mortality as a result of linear development installation, maintenance, or removal activities. As a result, interaction with the MC1's predicted substantive effect of mortality of bull trout is unlikely to occur, as long as the other projects identified are constructed and operated according applicable regulations, guidelines, and best management practices to reduce accidental fish mortality.

9.7 LAND USE AND MANAGEMENT AND INFRASTRUCTURE

One substantive adverse residual effect to Land Use and Management was identified as a result of implementation of MC1: reduction to recreational use.

No potential for interaction was identified between MC1-related residual effects on recreation use, nor on the residual effects of past, present, and reasonably foreseeable future projects within the Land Use and Management RAA. The backcountry trail remediation project occurs within the Land Use and Recreation RAA, but is planned to be completed in 2018; any residual effects to recreational use resulting from that project would not temporally overlap with those of MC1. It is possible that trails that have been remediated as part of the backcountry trail remediation project will be disturbed by the Option; however, disturbance of trails in the area has already been considered as part of the substantive residual adverse effect.

No interactions are expected with other identified future or reasonable foreseeable projects; therefore, no substantive cumulative effects to reduction in recreational use are likely to occur.

9.8 REFERENCES

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10.0 EFFECTS OF THE ENVIRONMENT ON THE MC1 OPTION

This section provides a high-level overview of the effects of the environment that may occur to the Elbow River Dam at McLean Creek (MC1) Option during its Construction and Operation and Maintenance phases. The MC1 Option has been developed at a conceptual level, and detailed studies to support this analysis are not available. The two factors of the environment considered to have the greatest potential to adversely affect the MC1 Option include the effects of the probable maximum flood (PMF) and failure of the Beaver Flats Landslide Complex on the MC1 dam, as discussed below. If the MC1 Option was advanced, the preliminary assessment of potential effects of the environment on the MC1 Option presented below would be refined during later stages of Option planning and development.

10.1 PROBABLE MAXIMUM FLOOD

The MC1 Option is intended to withstand the PMF, which is a flood event associated with unusually high rainfall or snowmelt, or both together, that has a very low probability of occurring (i.e., return period of 500 years or greater) (Alberta Transportation 2004). The PMF estimated for the SR1 Project, is to have a peak instantaneous flow of 2,770 cubic metres per second (m^3/s), which is substantially larger than the 2013 flood peak instantaneous flow of 1,240 m^3/s (**Table 10.1-1)**.

Table 10.1-1 Peak Flow Estimates for the Elbow River Dam at McLean Creek Option

Return Period (years)	20	100	2013 Flood	500	PMF
Instantaneous Maximum Flow (m^3/s)	440	930	1,240	1,984	2,770

10.1.1 DESCRIPTION

- As described in Opus 2017a, the PMF would pass the MC1 dam as follows:
- The water level in the reservoir would rise to a peak elevation of 1428.1 m;p
- The water would discharge first through the diversion tunnels, then the service spillway, and after that the auxiliary spillway;
- Peak outflow from the MC1 facility would reach 2,600 m3/s; and
- Flows through the auxiliary spillway would be required for approximately 24 hours.

10.1.2 MITIGATION BY DESIGN

A number of design features have been incorporated into the MC1 Option that anticipate, and address, potential effects of the PMF on the proposed infrastructure. These include controlling river flows through two gated diversion tunnels, storing water to the elevation of the service spillway, and an auxiliary (emergency) spillway. See **Section 3.0 Option Description** for details.

10.2 BEAVER FLATS LANDSLIDE COMPLEX

The Beaver Flats Landslide Complex, located approximately 8 kilometres (km) upstream of the eastern most extent of the reservoir and 12 km upstream of the MC1 dam site, is thought to be two distinct rock slides. Because the deposit of two rock avalanches is visible on both sides of the Elbow River, it is assumed that historic slide events dammed the Elbow River and led to outbreak floods. As reported by BGC Engineering Inc (BGC) (Opus 2017b), the Beaver Flats landslide, referred to as the north landslide (NLS), is thought to have occurred within the last 1,000 years. This landslide is believed to have originated on a steep rock face at an elevation of approximately 1,880 m, and descended over a distance of approximately 1,100 m (from the scarp to the furthest runout).

The Beaver Flats Landslide Complex is regarded as most likely to interrupt flows in the Elbow River, given the proximity to downstream infrastructure, two prehistoric rock avalanches, and the large storage afforded by the upstream channel geometry. Southeast of the failure slope, a large portion of the rock slope in presumably a similar geologic setting has not yet failed (Opus 2017b). This area is referred to as the middle landslide (MLS) (Opus 2017b). Further investigation undertaken by BGC (Opus 2017b) identified a third landslide area, the south landslide (SLS), which has also collapsed previously and dammed the Elbow River, as evidenced by well-preserved landslide deposits on either side of the existing channel.

10.2.1 DESCRIPTION

According to estimates from BGC (Opus 2017b), the height of the landslide dam resulting from the NLS may have been approximately 57 m. The landslide dam would have impounded approximately 62 million cubic metres (m^3) of water upstream of the NLS, assuming current channel and valley geometry. The peak flows resulting from a landslide dam breach were estimated to range from 4,300 m^3/s to 42,000 m^3/s. In absence of a field-based paleoflood hydrology analysis, it is not possible to state which of the peak flow estimates is more likely to correspond with future outburst floods from a landslide dam formed by the collapse of the MLS, should the slope fail catastrophically. However, the peak flows from such a failure would substantially exceed the peak flow estimates for hydrological floods (**Table 10.1-1**). The landslide dam outbreak flood would also induce dramatic channel changes downstream of the landslide dam that are similar to those described in Section 10.1, with respect to a failure of the MC1 dam.

The annual probability of rapid failure of the MLS was estimated through regional mapping of large (more than 1 million m^3) rapid rock avalanches and rock slides (rock slope failures) within a 3,300 square-kilometre (km^2) area (Opus 2017b). The analysis suggests an annual probability of failure of the MLS of up to approximately 1 in 3,000, or 0.0003; this implies a substantially higher frequency and magnitude of a landslide outburst flood than the PMF. The magnitude of the landslide outburst flood would be 4 to 42 times higher than the June 2013 flood of record.

As noted by BGC (Opus 2017b), the estimates provided are recommended for reassessment based on the following recommendations:

- Conduct a thorough paleoflood hydrology analysis to determine the likely discharges of the pre-historic NLS and SLS landslide outburst floods.
- Conduct fieldwork to understand the kinematics of the MLS and improve the estimates of the annual probability of a slope collapse.
- Numerically model the MLS runout to improve the estimate of the potential landslide dam geometry.
- Model bank erosion associated with the landslide outburst floods considered.
- Model the likely rates of sedimentation into the MC1 reservoir given landslide outburst flood.
- Conduct a quantitative risk assessment of landslide outburst floods and their effects on inundation and bank erosion to understand their potential consequences for loss of life and economic losses.

10.2.2 MITIGATION BY DESIGN

The MC1 Option may provide a level of protection to the downstream environment from a landslide dam outbreak flood. As described in Opus (2017b), the modelled landslide dam outbreak flood could be contained by the MC1 dam assuming a total reservoir storage volume of 93 million m^3, of which approximately 88 million m^3 would be available for flood storage between the permanent pond and the maximum reservoir level. This estimate is based on the assumption that a future landslide at the Beaver Flats Landslide Complex results in a landslide dam height of 57 m, stores 62 million m^3, and fails abruptly by overtopping. These assumptions are recommended to be examined through field work and landslide runout modelling. Should the landslide occur during a substantial flood at which the reservoir level is higher than modelled herein, the afforded flood storage would be proportionally lower.

10.3 REFERENCES

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11.0 ACCIDENTS AND MALFUNCTIONS

This section provides a high-level overview of accidents or malfunctions that may occur during the Construction and Operation and Maintenance phases of the Elbow River Dam at McLean Creek (MC1) Option, and presents the potential effects of such accidents and malfunctions on the environment. The MC1 Option has been developed at a conceptual level, and detailed studies, including geological and seismic evaluations and inundation modelling that would inform a detailed analysis of potential accident or malfunction scenarios, have not been completed. If the MC1 Option was advanced, the preliminary assessment of potential MC1-related accidents and malfunctions presented below would be refined during later stages of MC1 Option planning and development.

11.1 SCOPE

Accidents and malfunctions are defined as follows:

- Accident: an unexpected occurrence or unintended action
- Malfunction: failure of a piece of equipment, device, or system to function normally.

Potential accidents and malfunctions that may occur during the Construction or Operation and Maintenance phases of the MC1 Option were identified by considering the location of MC1 components and activities, design standards that would be applied to all MC1 components, and specifics of technologies used, as well as reviewing historical performance data for similar projects. Identification of potential accidents and malfunctions was guided by the study team's professional judgement based on experience with similar projects.

As discussed in **Section 3.3**, the MC1 Option would involve the construction of an earth fill dam (main dam), which would create a reservoir that would have the ability to retain water during major flood events. A cofferdam would also be constructed as part of the Option.Given the nature and scale of these works, and anticipated scope of Construction-phase activities associated with their development, the following key accident or malfunction scenarios could occur during the Construction or Operation and Maintenance phases of the MC1 Option:

- Earthworks failure of the main dam
- Earthworks failure of the cofferdam
- Release or spills of hazardous materials
- Failure of sediment-control measures

11.2 METHODOLOGY

This preliminary assessment of accidents and malfunctions generally follows the environmental assessment guidance, from Alberta Environment and Parks (AEP; AEP 2013) and the Canadian Environmental Assessment Agency (2015), and assessment results are presented in terms of the following:

- Key potential accidents or malfunctions that may occur during the life of the MC1 Option.
- Potential effects of MC1-related accidents or malfunctions on the biophysical and human environment.
- Design and implementation considerations aimed at reducing the likelihood of MC1-related accidents and malfunctions, and associated effects.
- Potential risks associated with each accident or malfunction, given the likelihood of occurrence and consequences resulting from it.

An overview of the potential nature of the above accidents and malfunctions, effects they may have on the environment, and measures for minimizing the likelihood of their occurrence are presented in the following subsections. A preliminary assessment of environmental risks associated with these potential MC1-related accidents and malfunctions is also included. The following risk assessment framework, based on the consequence of an accidents and malfunction scenario and the likelihood of it occurring, was used to characterize potential risks.

The likelihood and severity of an accident or malfunction is determined according to the attributes identified in **Table 11.2-1** and **Table 11.2-2**. These attributes have been developed based on professional judgement and environmental assessment best practice. The overall risk assessment result is calculated using **Table 11.2-3** as guidance.

Table 11.2-1 Definitions for Likelihood of an Event

Category	Description
Almost Certain	Event would be likely to occur in most circumstances and has a history of occurrence. Likely to occur once or more per year.
Likely	Event would probably occur in most circumstances. Likely to occur once in one to three years.
May	Event could occur at some point. Likely to occur once in every three to five years.
Unlikely	Event not likely to occur in normal circumstances. Likely to occur only once during the life of MC1.
Rare	Event could occur only in exceptional circumstances. Not likely to occur during the life of MC1.

Table 11.2-2 Definitions for Severity of an Event

Consequence Rating	Description
Severe	Biophysical: Resulting in structural and functional changes at the population level to an extent which could potentially result in severe changes at the community and ecosystem levels, or resulting adverse effects occur regionally and would take more than 10 years to reverse. Human Environment: Adverse effects would result in changes beyond historical norms and present a major management challenge. One or more fatalities may occur.
Major	Biophysical Environment: Resulting in some structural and functional changes at the population level above natural variation, or resulting adverse effects occur regionally and can be reversed in 10 years or less. Human Environment: Adverse effects would result in changes beyond historical norms and present a moderate management challenge.
Moderate	Biophysical Environment: Resulting in lethal and/or sub-lethal effects at the individual level indistinguishable from natural variation or resulting adverse effects are detectable and can be reversed in one year or less. Human Environment: Adverse effects would result in demonstrable change and are possible at the community-wide level, but remain within historic norms and present no or a minor management challenge.
Minor	Biophysical Environment: Resulting adverse effects are barely detectable and can be reversed in one month or less. Human Environment: Resulting adverse effects are detectable, but are not likely to be experienced at the community level.
Negligible	Resulting adverse effects are barely to not detectable and can be reversed in two days or less. Human Environment: Resulting adverse effects are not detectable, or are in the normal range of variability in the human environment.

Table 11.2-3 Risk Matrix

		Consequence				
		Severe	**Major**	**Moderate**	**Minor**	**Negligible**
Likelihood of Event Occurring	**Almost Certain**	Critical	Very High	High	Medium	Low
	Likely	Very High	High	High	Medium	Low
	May	High	High	Medium	Low	Very Low
	Unlikely	High	Medium	Medium	Low	Very Low
	Rare	High	Medium	Low	Very Low	Negligible

Source: Adapted from BC Risk Management Branch and Government Security Office, 2012

11.3 SCENARIO 1: EARTHWORKS FAILURE – MAIN DAM

11.3.1 OVERVIEW

A number of scenarios, including an earthquake or seismic event causing piping (seepage causing internal erosion of the dam) through the earth fill dam or its foundation and overtopping during the PMF could result in a failure of the main dam during the Operation and Maintenance phase. Such a failure, if it were to occur during or immediately following a major flood event, would result in the release of a substantial volume of water downstream of the dam, and a consequent increase in peak flow for a short period of time as this pulse of water moves downstream.

Additional studies would be required to refine risk and consequences of a failure of the main earth fill dam as a component of more detailed engineering design.

11.3.2 POTENTIAL EFFECTS

In the event of a dam failure, bank erosion and substantial scouring of the streambed would occur in the immediate vicinity of failure. Erosion and scouring could extend downstream to the point where total flow may approach peak flows (e.g., 1,240 m^3/s for the 2013 flood event; 1,984 m^3/s for the 500 year flood); this scenario would likely occur naturally during a large storm event. The spatial extent of inundation downstream of the dam, and incremental maximum water levels that could result from a failure, can be predicted through inundation modelling for the “with the MC1 Option” and “without the MC1 Option” scenarios using design details available during later stages of Option development. For the purposes of this preliminary discussion on potential MC1-related accidents and malfunctions, it is assumed that portions of the Bragg Creek and Redwood Meadows communities would be inundated in the event of a failure of the main dam.

Failure of the earth fill dam would release earth and debris into the Elbow River, and would result in the rapid drawdown of the reservoir water, which could result in landslides in areas where colluvium and glaciolacustrine deposits have been saturated by the reservoir. Some material deposited in the reservoir during normal operation would erode, resulting in an increase in sediment concentrations in the water flowing out through the breach. The high energy of flows escaping through a breach in the dam would result in scouring of the stream channel, and consequently, would increase the concentration of suspended solids in downstream waters. Suspended sediment would be diluted as it is carried downstream, and would settle out as flow energy decreases.

The release of a large volume of sediment, particularly during low flow periods, would affect fish and fish habitat in the watercourses downstream of MC1, including several fish species of management concern including westslope cutthroat trout (*Oncorhynchus clarkii lewisi*)bull trout (*Salvelinus confluentus)*, brook trout (*Salvelinus fontinalis*) (introduced), rainbow trout (*O. mykiss)*, cutthroat trout (O. *clarki)* (introduced), brown trout (*Salmo trutta*) (introduced), mountain whitefish (*Prosopium williamsoni)*, northern pike (*Esox*

Lucius), and burbot (*Lota lota)* (see **Section 7.3 Aquatic Environment**). Sediment can have a range of sub-lethal to lethal effects on fish, depending on the dose and duration of sediment exposure. Increased sediment concentrations can also affect feeding by influencing visual prey detection and changing the benthic community toward burrowing taxa. In addition, high volumes of sediment and water released during a failure could cause a debris flow down the stream channel, which could have an adverse effect on riparian and instream habitat, and lead to morphological changes of stream channels. Debris flows can also have an effect on the benthic invertebrate communities that are an important source of food for fish. Fish populations are anticipated to recover from the effects of a potential dam failure as the affected areas would end up being populated by similar species from neighbouring reaches and tributaries.

Wildlife within the flooded area could be injured or killed by the force of the flood wave released through a breach in the dam or impingement against obstacles, or could be drowned. Wildlife would move back into the area once the flood has receded and vegetation re-established.

Vegetation and ecological communities may be affected by direct damage or loss of vegetation on the flood's flow path due to scouring. Sediment may also smother vegetation, particularly if there is debris associated with the sediment transport. In addition, a sedimentation event would introduce fine particles into the water column of affected watercourses that could affect riparian habitat. In areas inundated by waters released by a dam failure, some vegetation such as grasses and shrubs would regrow fairly quickly, but damaged or uprooted trees would take longer to re-establish. Some ecological communities might not re-establish.

A failure of the main dam would adversely affect land and resource use due to its effects on fish, wildlife, and vegetation, as described above, as well as effects on agriculture, livestock, and forestry. Land and resource use may take months or seasons to recover. Depending on the amount of erosion, effects on agricultural land or crops may last one or more seasons. Other effects on the human environment are anticipated to include damages to community infrastructure such as roads, highways, trails, and transmission lines; the Bragg Creek and Redwood Meadows communities; outdoor recreation and tourism; and visual and aesthetic resources of the river valley downstream.

Failure of the main dam could adversely affect public health and safety because residences, recreational areas and water intakes could be inundated by waters released through any breaches in the dam. The provincial Emergency Preparedness Plan would be implemented, and people within the potentially flooded areas would be evacuated; however, there is potential for some loss of life or injury, and some evacuees may be affected by post-traumatic stress.

11.3.3 MC1 OPTION DESIGN AND OPERATIONAL CONSIDERATIONS

At a minimum, the MC1 Option would be designed, constructed, operated, and maintained to follow the Canadian Dam Association Dam Safety Guidelines (CDA 2007) and the Alberta Dam Safety Guidelines (AEP 2016). The consequence classification rating for the MC1 dam under these guidelines would be extreme due to the downstream population at risk; therefore, the Option would be designed to the PMF.

During the Operation and Maintenance phase, the diversion tunnels would convey normal flows and the reservoir would be dry above the permanent pond. Trash racks would be installed at the entrance of the diversion tunnels to allow free water passage to maintain the reservoir water level. The service spillway and auxiliary spillway would be activated to protect the main dam during a PMF event.

Preliminary exploration of the geology of the site indicates that there are granular deposits within the left and right abutments of the dam. To prevent water from seeping through these deposit zones and potentially cause internal erosion (piping), a well-founded and continuous slurry wall would be constructed.

The MC1 dam would be monitored during the Operation and Maintenance phase. In the event of a trigger indicating dam instability, or failure of the earth fill dam, the Emergency Response Plan would be triggered. Notifications would be given immediately to appropriate managers and supervisors. As appropriate, these notifications would be extended to regulatory agencies. Control of the situation would be transferred to the Emergency Response Team. Actions, such as evacuation, would be taken immediately to protect the safety of employees, site personnel, and the public. Actions would also be taken to assess the potential effects to the environment. Monitoring and assessment programs would be initiated to identify any residual effects in the receiving biophysical and human environment.

11.3.4 RISK ASSESSMENT

The likelihood of failure of the earth fill dam was evaluated based on a review of the general industry statistics and MC1-specific conditions and facility details. The likelihood of failure of conventional water retention dams was reported by the International Committee on Large Dams to be 0.01% over 100 years (ICOLD 2001); hence, a failure of the earth fill dam is considered rare (**Table 11.2-1**). Due to the risk of human fatalities, the consequence of a dam failure is considered to be severe (**Table 11.2-2**). On this basis, and taking into account the risk matrix (**Table 11.2-3**), the risk associated with failure of the earth fill dam is high.

11.4 SCENARIO 2: EARTHWORKS FAILURE – COFFERDAM

11.4.1 OVERVIEW

A cofferdam, an earth embankment with a clay core, would initially divert water into the diversion tunnels to facilitate construction of the main dam. With diversion tunnels fully open, the cofferdam would provide protection from a 1:50 year flood event.

A rock groin would be installed within the Elbow River to facilitate the construction and protection of the cofferdam by channelling river flows into the diversion tunnels. During the Construction phase, the diversion tunnels would be fully opened to allow for water to freely pass through.

As with the main dam, scenarios such as an earthquake or seismic event, or piping through the dam or its foundation could result in failure of the structure during the Construction phase. Such a failure would result in the release of a large volume of water and material from the dam to the downstream environment.

11.4.2 POTENTIAL EFFECTS

The potential effect of a failure of the cofferdam would be similar to those associated with failure of the main dam, as discussed earlier under **Section 11.3**, but of a lower scale and magnitude, given the substantially lower volume of water that would be retained by the cofferdam when compared to the main dam. These potential effects would include scouring of stream bed and bank erosion in the vicinity of the failure; inundation of downstream areas; increase in sediment load in downstream waters; loss and damage of terrestrial and aquatic habitat; mortality or injury of fish and wildlife; and social, economic, and public health and safety consequences.

11.4.3 MC1 OPTION DESIGN AND OPERATIONAL CONSIDERATIONS

Best practices recommend cofferdams are designed to handle 1:20 year flood event, plus 1 m of freeboard. The cofferdam for the MC1 Option, as described earlier, would be designed to handle a 1:50 year flood event, plus 3 m to 5 m of freeboard.

Emergency response measures would be the similar to those for the main dam, as described in **Section 11.3.3**.

11.4.4 RISK ASSESSMENT

The likelihood of failure of the cofferdam was evaluated based on a review of the general industry statistics and MC1-specific conditions and facility details. Based on a review of the general industry statistics (ICOLD 2001) and MC1-specific designs, the likelihood of failure of the cofferdam is considered rare (**Table 11.2-1**). As the maximum storage capacity of the cofferdam is less than half of that of the main dam, the potential effects associated with the failure of the upstream cofferdam would be similar to those

described in **Section 11.3.2** for the main dam, but substantially lower in severity and geographic extent. Due to the risk of human fatalities, the consequence of a dam failure is still considered to be severe (**Table 11.2-2**). On this basis, and taking into account the risk matrix (**Table 11.2-3**), the risk associated with a failure of the cofferdam is high.

11.5 SCENARIO 3: RELEASE OR SPILLS OF HAZARDOUS MATERIALS

11.5.1 OVERVIEW

Fuel, oil, and other hazardous materials needed for the operation of trucks, excavators, loaders, and other equipment to be used during the Construction and Operation and Maintenance phase could be accidentally released to the environment through spills during equipment refuelling, equipment malfunction, rupture of storage vessels, or a motor vehicle accident.

The accidental discharge of a deleterious substance such as a petroleum hydrocarbon, uncured concrete, or concrete-affected water to the receiving environment could occur during the Construction phase. During routine operation, on-site fuel storage would be minimal, limited to the quantities needed to operate the diesel generator that powers the spillway gate operations. Diesel and other hazardous materials would be located in appropriate secondary containment systems within the maintenance facility. Fuel or fuel equipment would not be stored within 100 m of a watercourse.

11.5.2 POTENTIAL EFFECTS

Hazardous material spills could contaminate soil, air, or water, damage vegetation, and possibly be toxic. Spills to the aquatic environment may harm fish and other aquatic species, and degrade fish habitat and surface water quality. Dependant on the magnitude of the spill, there may be an adverse effect on land and resource use due to potential effects on fish, vegetation or wildlife.

11.5.3 MC1 OPTION DESIGN AND IMPLEMENTATION CONSIDERATIONS

The potential for the release or spill of hazardous materials to the receiving environment can be reduced through the application of best management practices (BMPs). In accordance with Alberta Transportation standard practice, BMPs and standard mitigation measures would be included in the Environmental Construction Operations (ECO) Plan that would be developed by the contractor prior to the start of construction (Alberta Transportation et al. 2014).

The following measures that would be implemented during the Construction or Operation and Maintenance phases as required, to avoid or mitigate potential effects of spills, are anticipated to include the following:

- Adhere to the Petroleum Tank Management Association of Alberta guidelines (PTMAA 2016) and Part 4 of the Alberta Fire Code (NRCC 2014).
- Chemical contaminant measures

- Blast management measures, with application of Fisheries and Oceans Canada *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright & Hopky 1998) to be followed to mitigate potential effects associated with blasting in places where blast residue may enter watercourses
- Cementitious materials management measures
- Contaminated soil containment measures
- Spill management measures.

11.5.4 RISK ASSESSMENT

The environmental fate of a petroleum hydrocarbon spill (e.g., gasoline, diesel, lubricating and hydraulic oils) of the magnitude that could occur as part of the MC1 Option generally would be short term (in the order of days to weeks). A spill disperses or breaks down by way of evaporation into the atmosphere, photodegradation by sunlight, and biodegradation by bacteria. An accidental spill of other hazardous materials is likely to be more localized compared to an accidental spill of petroleum hydrocarbons.

The magnitude of a potential spill of hazardous materials would depend on a number of factors including the type of product, quantity, location, and timing of the spill. Based on the quantities and types of products likely to be on-site, following effective implementation of the mitigation measures described above, adverse effects are likely to range from low to moderate in magnitude, would be of short to moderate term in duration, and would be local in geographic extent. Effects are anticipated to be reversible through the implementation of spill management measures, clean-up and restoration efforts, and the ecological setting is considered to be disturbed, based on the existing agricultural and other human activities in the watershed. The potential consequences of an accidental spill of hazardous materials are therefore considered minor to moderate (**Table 11.2-2**).

Given operational considerations, including storage of minimal quantities of potentially hazardous material on-site, and proposed BMPs as outlined earlier, the probability of a substantial spill during construction or operation of MC1 is considered unlikely (**Table 11.2-1**); therefore, the risk associated with the release or spill of a hazardous material is low to medium (**Table 11.2-3**).

11.6 SCENARIO 4: SEDIMENT CONTROL FAILURE

11.6.1 OVERVIEW

Erosion and sediment control measures, including bank stabilization procedures to prevent entry of sediment into watercourses, would be installed during the Construction phase, and would be maintained until re-vegetation, or other slope stabilization, is complete to prevent sediment transport. Surface drainages would be isolated from upland work areas with silt barriers or directed to one or more detention ponds if silt barriers are ineffective in preventing sediment transport. The quantities and duration of sediment

mobilization from a sediment control failure would vary, depending on the location and type of sediment control structure.

During the Operation and Maintenance phase, some of these erosion and sediment control measures would also be needed and would need to be maintained.

11.6.2 POTENTIAL EFFECTS

The potential effects of a sediment control failure would be of a much smaller scale and magnitude than the failure of the cofferdam (**Section 11.4**), A failure of sediment and erosion control measures during the Construction phase could have an adverse effect on surface water quality, and fisheries and aquatic habitat in the Elbow River through the mobilization and deposition of sediment. Increased turbidity in the water column may adversely affect the photosynthetic activity of periphyton. Sediment and fine material may accumulate on stream bottoms, altering substrate composition. As well, increased TSS may lead to scouring, filling, or clogging limiting benthic living space and productivity, and may effect fish (direct mortality, indirect effects (e.g., avoidance)).

Dependant on the magnitude of the sediment control failure, there may be an adverse effect on land and resource use due to potential effects on fish, vegetation or wildlife.

11.6.3 MC1 OPTION DESIGN AND CONSTRUCTION CONSIDERATIONS

In accordance with Alberta Transportation standard practice, BMPs and standard mitigation measures would be included in the ECO Plan that would be developed by the contractor prior to the start of construction.

Erosion and sediment control measures installed as part of the Erosion and Sediment Control Plan for the Option would be designed and sized to meet site-specific requirements, routinely monitored and maintained, and immediately repaired as necessary throughout the Construction phase. The Erosion and Sediment Control Plan would require a stockpile of erosion and sediment control materials to be maintained on-site for ready access in the event of the failure of an erosion control structure. This plan would also identify the frequency of environmental monitoring for sediment control measures, and would provide direction on when environmental monitoring would be increased during periods immediately prior to, during, and after high rainfall events.

Turbidity would be monitored at sites upstream and downstream of points of potential entry of sediment from ground disturbance activities to verify compliance with applicable water quality guidelines for the protection of aquatic life during construction. If these measurements show that Construction-phase activities are not in compliance, work causing the noncompliance would be immediately stopped, and additional sediment control measures would be implemented. Once additional measures are implemented,

work would restart and measurements would be repeated to check compliance. This check on compliance would continue at a regular frequency throughout the period of ground excavation and disturbance.

11.6.4 RISK ASSESSMENT

Following effective implementation of measures for addressing a potential failure of erosion and sediment control measures during the Construction phase, as described above, and depending on the extent and location of the failure, as well as the nature of the structure, the consequences of such failures are considered minor (**Table 11.2-2**). With frequent monitoring and inspection as proposed, the likelihood of failure of MC1-related erosion and sediment control may occur (**Table 11.2-1**); therefore, the risk associated with the failure of a sediment control structure is low (**Table 11.2-3**).

11.7 REFERENCES

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12.0 CONCLUSION

Alberta Transportation investigated MC1 as the alternative means to the SR1 Project. The MC1 Option would be located in Kananaskis Country, approximately 10 km upstream from the hamlet of Bragg Creek and 40 km west of Calgary, and has been developed to a conceptual level of design. This Environmental Impact Screening Report (Report) assesses the environmental, social and economic effects of the MC1 Option.

This Report describes the Option design, as well as best management practices and effects-specific mitigation to avoid or minimize potential effects of MC1. Mitigation measures have also been integrated into the Option design, including the incorporation of fish passage to facilitate fish movement and migration during the Option's Operation and Maintenance phase. VC-specific mitigation measures identified in this Report would be incorporated into an ECO Plan, as well as an Erosion and Sediment Control Plan, to avoid or minimize potential effects that could occur as a result of Option activities. Baseline information used to support the assessment of effects of MC1 include publicly available information, information collected for the SR1 Project, as well as field studies for vegetation and wetlands, fish and fish habitat, and wildlife and wildlife habitat.

Based on available information, the results of the effects assessment indicate that five VCs are likely to experience residual adverse effects that are considered to be substantive, as a result of construction and operation of the Option:

- Fluvial Geomorphology: changes to channel morphology
- Vegetation and Wetlands: reduction in biodiversity due to loss of tracked plant species
- Wetlands: reduction in wetland area and function
- Fish and Fish Habitat: increased risk of fish mortality and reduced productivity for bull trout
- Land and Resource Use: reduction to recreational use

Additionally, the Option would be likely to have the following positive substantive residual effects:

- Socio-economic Resources: an increase in provincial and regional economies
- Health and Safety: improved emergency preparedness / response and reduced health and safety risk during a flood event

All substantive adverse residual effects were brought forward into the Planned Development Case, and screened against past, present, and reasonably foreseeable projects and activities to determine if a substantive adverse cumulative effect could occur. No potentially substantive cumulative effects were identified.