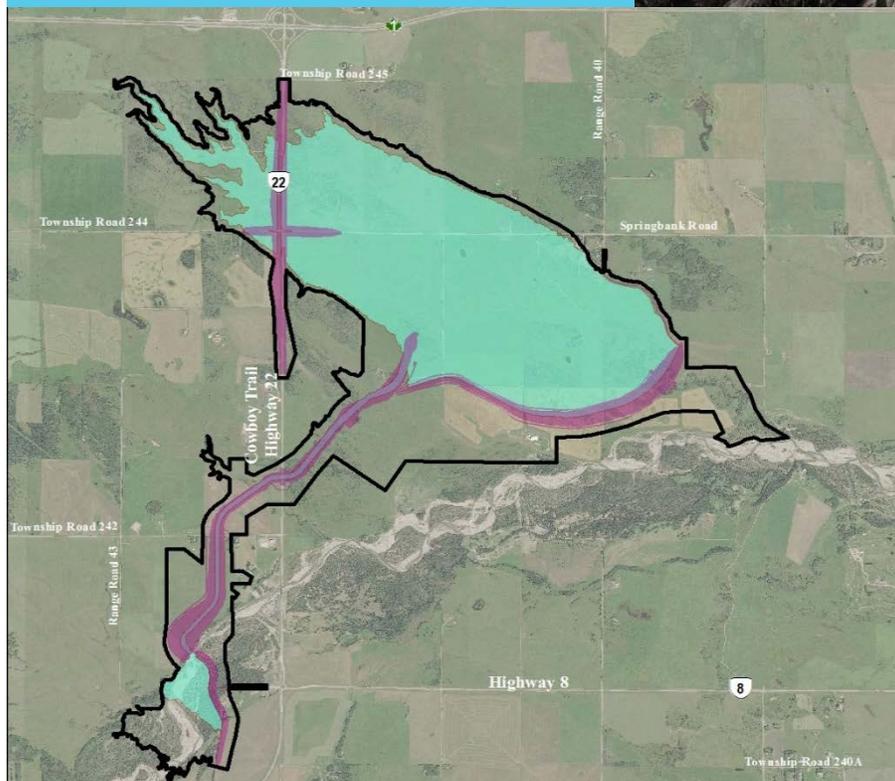


Springbank Off-stream Reservoir Project

Environmental Impact Assessment



Volume 3C Effects Assessment (Cumulative Effects, Follow-up and Monitoring)

March 2018

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ENVIRONMENTAL IMPACT ASSESSMENT
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1.0 CUMULATIVE EFFECTS

1.1 INTRODUCTION

1.1.1 Organization of the Cumulative Effects Assessment

This assessment of potential cumulative effects is organized as follows:

- Introduction
 - **Basis of Assessment**—summarizes key considerations on which the assessment of potential cumulative effects is based.
 - **Selection of VCs**—identifies the Valued Components (VCs) assessed or not assessed.
 - **Project Inclusion List**—identifies other past, present or future projects or physical activities that may interact cumulatively with residual effects of the Springbank Off-stream Reservoir Project (the Project)
 - **Regional Context**—an overview of the Project within the regional landscape of southern Alberta.
 - **Approach to Assessing Cumulative Effects for Each Scenario**—additional details on the method used
- Cumulative effects assessment for construction and dry operations, including mitigation measures.
- Cumulative effects assessment for flood and post-flood operations, including mitigation measures.
- Conclusions

1.1.2 Basis of Assessment

The Alberta Environment and Parks (AEP) Terms of Reference for the Project requires that the environmental impact assessment address the potential for cumulative effects. The Canadian Environmental Assessment Agency Guidelines for the Project requires that the environmental impact assessment identify and assess the Project's cumulative effects using the approach described in the Agency's Operational Policy Statement entitled *Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act 2012* and the guide entitled *Cumulative Effects Assessment Practitioners' Guide*.

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This section assesses the project effects that have the potential to act cumulatively with effects of other projects and activities in the regional assessment areas (RAAs) of the valued components (VCs). The basic methods for assessing cumulative effects are presented in Volume 2, Section 7.2, with further details discussed below in Section 1.1.6.

The assessment of cumulative effects is presented consistent with the residual effects assessment: the assessment of effects is considered for the Project in two scenarios: construction and dry operations; and flood and post-flood operations. The cumulative effects assessment evaluates flood and post-flood operations that include consideration of overlapping infrastructure (pipelines, transmission lines, roads), other flood mitigation works, and considers the effects from reasonably foreseeable projects in regional and community development plans.

Cumulative effects for accidents and malfunctions during construction, flood and post-flood operations for overlapping existing and potential future projects including pipelines, transmission lines and road infrastructure are addressed in Volume 3D, Section 1.8.

1.1.3 Selection of VCs

The cumulative effects assessment builds on the Project-specific residual effects assessments presented in Volumes 3A and 3B. In accordance with the the Canadian Environmental Assessment Agency Guidelines for the Project (Section 6.6.3), a cumulative effects assessment is required for a VC only where the Project may result in adverse residual effects on that VC; if a VC would not be affected by the Project or would be affected positively, then it may be omitted from the cumulative effects assessment.

1.1.3.1 VCs Assessed in Both Scenarios

The Project-specific VCs for which adverse residual effects are anticipated during both assessment scenarios and, therefore, also assessed for potential cumulative effects in both scenarios are:

- air quality and climate
- hydrogeology
- surface water quality
- aquatic ecology
- terrain and soils
- vegetation and wetlands
- wildlife and biodiversity
- land use management
- traditional land and resource use
- public health
- infrastructure and services

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1.1.3.2 VCs only Assessed in Flood and Post-flood Operations

The Project-specific VC for which adverse residual effects are anticipated only during the flood and post-flood operations and, therefore, also assessed only for potential cumulative effects in that scenario, is hydrology. Hydrology was not assessed for construction and dry operations because Project-specific environmental effects on hydrology and sediment transport, with the implementation of mitigation measures, are neutral (i.e., no net change in measurable parameters for hydrology relative to existing conditions). In the absence of residual effects, there is no pathway for cumulative effects and, therefore, no cumulative effects assessment is warranted for hydrology during construction and dry operations.

1.1.3.3 VCs Not Assessed in Either Scenario

The Project-specific VCs for which adverse residual effects are not anticipated during either assessment scenarios and, therefore, are not assessed for potential cumulative effects, are:

- acoustic environment
- employment and economy
- historical resources

The following explains why these VCs are not assessed for potential cumulative effects.

Reason for Exclusion of Acoustic Environment VC

Construction and Dry Operations

Due to the preliminary status of the construction execution plan, the potential effects of construction and dry operation on the acoustic environment are modelled without the application of mitigation measures. The unmitigated sound levels at most receptor locations during some phases of construction exceed the noise limits, based on Health Canada's preferred approach for environmental assessments. However, with the application of mitigation, the residual effect on the acoustic environment are expected to be reduced to achieve Health Canada's noise objectives. Upon availability of the detailed construction execution plan, mitigation measures will be developed to meet assessment noise thresholds. No residual effects are predicted. In the absence of residual effects, there is no pathway for cumulative effects and, therefore, no cumulative effects assessment is warranted.

Flood and Post-flood

During the post-flood phase, inspections would be conducted using light trucks, although some heavy equipment might be brought to site if it is needed for debris removal or facility maintenance and repair. The quantity of equipment required would depend on the severity of the flood. The maximum quantity of heavy equipment required during the post-flood operation

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would be substantially less than the equipment requirement for construction. Noise effect at all receptors are expected to be below the MNL threshold of 57 dBA L_{dn}, given the lower intensity of activities expected during post-flood operations. Therefore, residual effects on the acoustic environment during post-flood are not predicted. In the absence of residual effects, there is no pathway for cumulative effects and, therefore, no cumulative effects assessment is warranted.

Reason for Exclusion of Employment and Economy VC

Construction and Dry Operations

Potential adverse effects of Project spending relate to increased operational costs due to wage inflation and employee turnover. However, with the implementation of mitigation, it is anticipated that adverse project-specific effects on labour availability will be negligible (i.e., no measurable change from existing conditions). In the absence of residual effects, there is no pathway for cumulative effects and, therefore, no cumulative effects assessment is warranted.

Flood and Post-flood

In consideration of existing mitigation measures, the financial cost of 1:50 year, 1:100 year, and design floods from Elbow River, in the absence of the Project, is estimated at approximately \$470 million, \$1.1 billion, and \$1.9 billion, respectively. With the average annual damage (AAD) estimated at approximately \$42 million, construction of the Project would reduce the AAD of floods by \$28 million to \$14 million. Over an assumed 100-year operating life, the Project's discounted benefits in terms of flood damage avoidance, exceed its costs; therefore, it would have a net economic benefit. Given that the residual effect will be positive, no cumulative effects assessment is required.

Reason for Exclusion of Historical Resources VC

The following applies to both scenarios.

Project-specific environmental effects on historical resources will be mitigated to the standards established by Alberta Culture and Tourism (ACT). With mitigation following the recommendation of ACT, no adverse residual environmental effects on historical resources are anticipated. In the absence of residual effects, there is no pathway for cumulative effects and, therefore, no cumulative effects assessment is warranted.

1.1.4 Project Inclusion List

Other projects or physical activities that have been or will be carried out are identified for inclusion in the cumulative environmental effects assessment, based on their potential for residual environmental effects that could interact spatially and temporally with the residual environmental effects of the Project. The assessment considers the nature and degree of

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change from these existing conditions due to both the Project and the other projects or activities.

The environmental effects of other past and present projects or physical activities that have been carried out are reflected in the existing environment within the RAA. Such effects were also considered in the existing conditions for the Project-related environmental effects assessment for each VC (Vol. 3A and 3B) within the local assessment area (LAA).

The other projects or physical activities identified for consideration in the cumulative environmental effects assessment for this EIA are listed in Table 1-1, referred to as a Project Inclusion List (PIL). Future projects and physical activities were identified from publicly available information and are "certain, planned, or reasonably foreseeable" as per CEAA guidelines. Figure 1-1 illustrates the location of the future projects and physical activities.

Table 1-1 Other Projects or Physical Activities for Consideration of Cumulative Environmental Effects

General Category of Projects or Physical Activity	Specific Project or Activity	Description
Past and Present (have been carried out)		
Agriculture	Use of land or resources for ranching or farming activities	Agricultural activities, such as ranching or farming, have occurred in the region west of Calgary for over 120 years.
Infrastructure	Roads	A network of roads and road allowances exists within the Project Development Area (PDA) and region. These include, through the PDA: Springbank Road, Highway 22 and several township and range roads (Range Road 40, Township Roads 242 & 250).
	Power transmission	Power transmission lines have existed in the region for 90 years.
	Pipelines	Several pipelines and associated facilities (e.g., compressor station) occur in the area. The PDA overlaps with several operating, abandoned or inactive pipelines. The active pipelines carry a variety of substances including high-pressure and low-pressure product (e.g., natural gas).
	Telecommunications	Communications services, in the form of cables and towers, have existed in the region for 90 years.
	Bank Stabilization	Alan Grant Young has a disposition for Bank Stabilization (DLO 010386) at 05-03-024-04-W5, 06-03-024-04-W5 and 11-03-024-04-W5.

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Table 1-1 Other Projects or Physical Activities for Consideration of Cumulative Environmental Effects

General Category of Projects or Physical Activity	Specific Project or Activity	Description
	Surface Material Extraction Site	Alberta Transportation has a Surface Material Extraction Site (DRS 1006) at NW-11-024-04-W5.
	Fisheries Habitat Protection Area	Canmore's AEP Fish and Wildlife Office has a Fisheries Habitat Protection Area disposition (DRS060074) covering 49.1 ha in NE-11-024-04-W5. Foot access only for fishing and hiking.
	Watercourse Protection	The AEP's Rangeland District Lands Division Calgary Office has a Watercourse Protection Protective Notation (PNT753998) for 84.34 ha in NE-11-024-04-W5 and NW-11-024-04-W5. (Elbow River Boy Scout Camp - High Recreational Value, No Timber Removal).
Residential and communities	Residential dwellings and communities	Residential areas have and will continue to develop west of Calgary. These include Springbank, Bragg Creek, Redwood Meadows, and acreages off Hwy 8 near the PDA.
	Community of Harmony	The Community of Harmony Stage 1 conceptual scheme was adopted by the County of Rocky View in 2007 for the development of a community on approximately 707 ha of land adjacent to the Springbank Airport, to include residential, commercial/retail, infrastructure, institutional and tourism/recreational components. In 2008, Stage 1 Neighborhood Plan was approved; and in 2015 development permits issued and 15 show homes built.
	Reserves	The Tsuut'ina Nation (Reserve 145) is located 395 m south of the PDA. The Stoney Nation (Reserves 142, 142B, 143 and 144) is also located near the PDA.
Recreation and tourism	Kamp Kiwanis	Kiwanis Club of Calgary's Kamp Kiwanis was founded in 1951, and serves to provide the summer camp experience to underprivileged children and families. The Kamp is in the PDA.
	Camp Gardner	Scouts Canada has held the lease for Camp Gardner from July 1966 until 2017. Hope Mission currently runs a recreational camp for children at the site. Their lease expires in July 2018. The Camp is in the PDA.

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Table 1-1 Other Projects or Physical Activities for Consideration of Cumulative Environmental Effects

General Category of Projects or Physical Activity	Specific Project or Activity	Description
	Backcountry Trail Remediation	Remediation in Rocky View County is being undertaken by Alberta Environment and Parks (AEP) on trails with erosion and other damage to bridges and amenities from the June 2013 flood. The program will restore priority trails and trails systems along the eastern slopes that are used for motorized and non-motorized recreational users. Some trails may be re-established in more ecologically appropriate and sustainable areas so they are better suited to withstand future floods. Trail systems near Bragg Creek, including the Diamond T-loop and Jumping Pound Ridge, will be evaluated. The program ran from June 2014 – March 2017.
	Redwood Meadows Golf and Country Club	A golf course within the Community of Redwood Meadows
	Calgary to Cochrane Trail - Phase 1	Phase 1 has been completed by the Glenbow Ranch Park Foundation. The “C to C Trail” will join the northwest corner of Calgary (via Haskayne Park) to Glenbow Ranch Provincial Park to provide opportunities for walking, hiking and biking. It will fill a gap in the Trans Canada Trail. Phase 1, the 2.2 km Bearspaw Trail, was constructed in September 2015 between the City of Calgary and Michael's Creek in Glenbow Ranch Provincial Park on the north side of the Bow River.
	Historic Site	The 'Our Lady of Peace' Roman Catholic Mission (est. 1872), a protected provincial historic resource, is located close to the diversion structure and channel component of the Project. The associated cairn site is located approximately 30 m from the PDA.
City of Calgary		Continuing development in the City of Calgary

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Table 1-1 Other Projects or Physical Activities for Consideration of Cumulative Environmental Effects

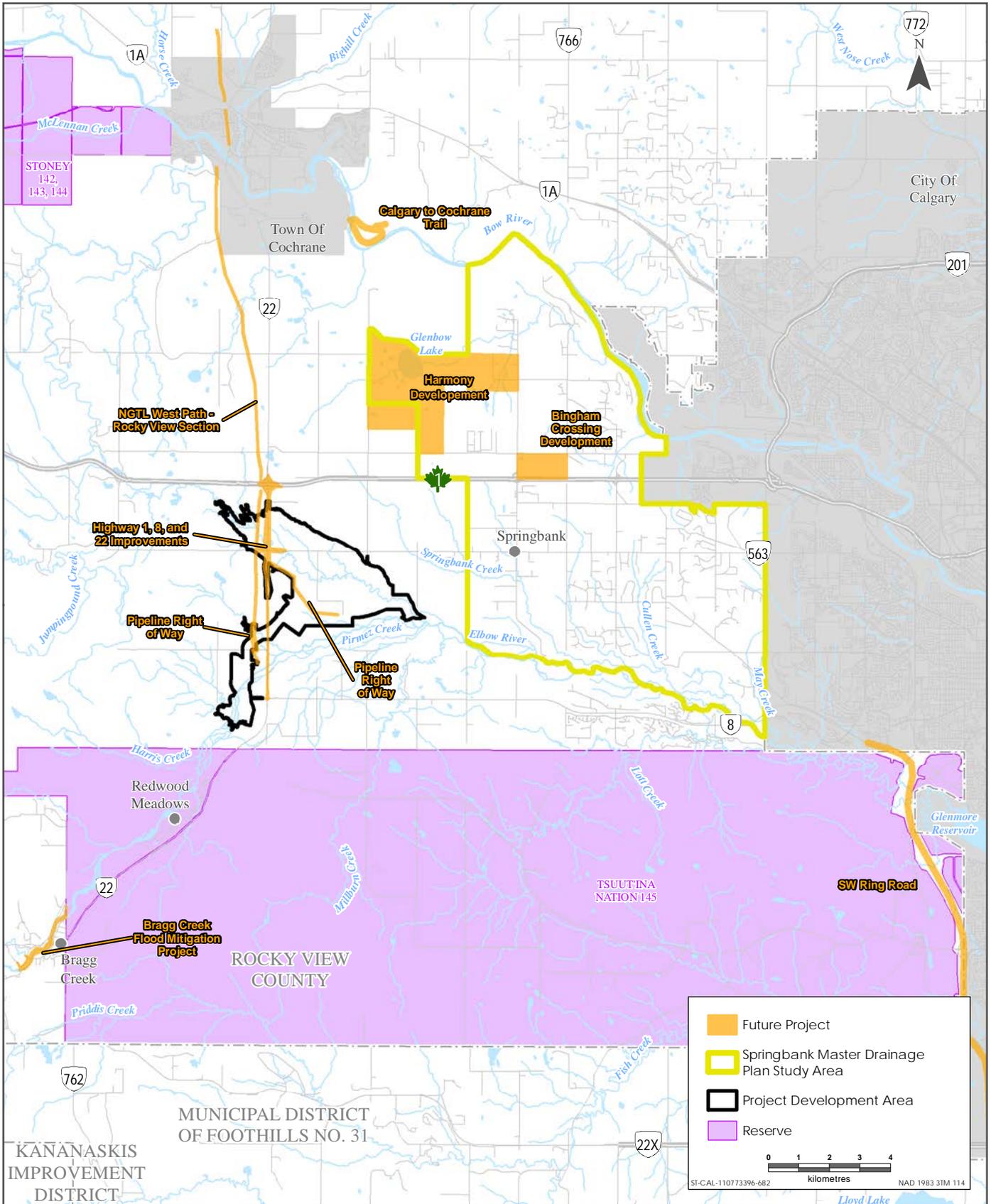
General Category of Projects or Physical Activity	Specific Project or Activity	Description
Future (may or will be carried out), see Figure 1-1		
Residential communities and business development	The Community of Harmony - Stages 2 and 3	Development on approximately 700 ha includes residential, commercial, recreational, infrastructure and institutions. Stage 2 construction starts 2019. By 2020 Harmony anticipated population of 1,200 in over 500 homes. Development will continue beyond 2020 in the same approved development area; however, no specific details are available.
	Bingham Crossing	A pedestrian oriented shopping and lifestyle with a seniors housing complex development in approximately 60 acres. Development is scheduled to be complete in 2019; however, minimal construction has so far occurred. and no further details are available.
	City of Calgary	Developments within City of Calgary. Several residential, commercial/retail, infrastructure, and institutional projects within the City of Calgary are planned for development.
Roads and Trails	Upgrades to Highways 1, 8 and 22	Upgrading of: Highway 1 and 22 interchange; Highway 8 and 22 interchange; and Highway 22 to four lanes and ultimately six lanes. These future road developments are not listed in the Provincial Construction Program for 2017-2020, assumed that construction start after 2020. No specific footprint details are available.
	Southwest Calgary Ring Road (SWCRR)	The SWCRR will connect Highway 8 to Macleod Trail SE. It will consist of 31km of six and eight lane divided highway. Major construction commenced in early 2017 and is expected to be completed in 2021.
	Calgary to Cochrane Trail - Phase 2 and 3	Phase 2 involves building a railway crossing along the Bowbend Trail pathway (by 2018) and Phase 3 involves building a pedestrian bridge over the Bow River near Cochrane (by 2020).
Pipelines and Transmission Lines	Realignment of existing pipelines and utilities in PDA	Oil and gas pipelines within the PDA would either be relocated within the PDA or retrofitted. One power line crosses the diversion channel and some power pole locations would be adjusted to permit a clear span over the channel. Alterations to infrastructure would occur in 2019-2020.

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Table 1-1 Other Projects or Physical Activities for Consideration of Cumulative Environmental Effects

General Category of Projects or Physical Activity	Specific Project or Activity	Description
	NGTL West Path Rocky View Section pipeline	A 21.5 km, 42-inch diameter, natural gas pipeline paralleling and adjacent to existing pipeline right-of-way extending between Cochrane and an existing valve station just north of the Elbow River. The right-of-way crosses underneath the Springbank Off-stream Reservoir Project diversion channel. Construction is anticipated from 2019 to 2020.
Water Management	Bragg Creek Flood Mitigation	Flood defenses in Bragg Creek consisting of earth dykes, concrete retaining walls, rock erosion protection and drainage systems. Detailed engineering design is currently undergoing regulatory review and approval. Construction is proposed from May 2018 – February 2019, with site reclamation and clean up occurring from May – November 2019. Final footprint details are currently not available.
	Rocky View County Springbank Master Drainage Plan	This plan, prepared in 2016, proposes requirements to manage stormwater runoff from future development in the community of Springbank and to address existing drainage issues. No specific footprint of infrastructure is yet available.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada Thematic Data - Alberta Environment and Parks (AEP), Alberta Conservation Information Management System (ACIMS), ERBC, Government of Alberta, Stantec Ltd

Future Projects and Physical Activities

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1.1.5 Regional Context

Originally mixed-grass prairie, the regional landscape surrounding the Project site, has been largely converted since the late 1800s to agriculture and settlement. The region is now a mosaic of various types of development (e.g., urban, industrial, infrastructure), agriculture and native grassland cover types with some other remnant vegetation patches, some along riverine valleys.

The PDA reflects this general landscape, mostly ranch and farm on private land, and, slightly beyond its boundaries, by individual residences, camps and rural sub-divisions (especially Springbank to the east). Roads, pipelines and transmission lines cross the PDA or are adjacent.

The City of Calgary, about 8 km east of the Project site, dominates the region as a major metropolitan centre with a population of about 1.4 million. A dominant land use in the region is the Tsuut'ina Nation reserve, about half kilometre south of the Project site. The population of the reserve is about 2,000.

This landscape is reflected in the five major land use groupings in the PIL: agriculture; infrastructure; residential and communities; recreation and tourism; and the City of Calgary.

The Project is of relatively small size in this landscape, as measured by permanent surface features. The size of the PDA on maps (e.g., Volume 1, Figure 1-1) appears much larger than what one would experience (as project surface features) if one were to walk across the project site. That is because a large portion of the PDA (the off-stream reservoir), when in operation, would be flooded. During dry operations, it is left fallow or may continue with agricultural use (as most of the PDA is pasture or grassland). Specifically, the permanent area of the PDA is about 179 ha, or 12% of the total PDA of about 1,438 ha, the difference in area is maximum flooded extent of the reservoir during a design flood (1,259 ha).

In consideration of the above, the nature and extent of cumulative effects of the Project with other projects and physical activities is generally limited. Many of the Project's effects are relatively spatially confined to the PDA or much smaller areas within it. Being in a rural area, other developments often are dispersed and sufficiently distant reduce the likelihood of cumulative effects. In contrast, there is some likelihood for cumulative effects in the case of roads and other rights-of-way that traverse through or near the PDA, or for some users traversing onto the land.

1.1.6 Approach to Assessing Cumulative Effects for Each Scenario

The following provides an explanation, given some unique aspects of both the Project and the assessment, of how the two scenarios were assessed in consideration of other projects and activities and the regional context. The first scenario is construction and dry operations and the second is flood and post-flood operations. Note that these encompass the four project *phases*, which is each of those four activities named in the scenario names.

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In Section 1.2, each VC includes a table entitled “Interactions with the Potential to Contribute to Cumulative Effects”. This table identifies which past, present and future projects effects may interact with the same effects (for the same VC) for the Project. These interaction tables, like the PIL, are organized by past and present, and then future. The “project-related physical activities” row recognizes for completeness the Project’s effects.

1.1.6.1 Construction and Dry Operations

The effects of the Project are assessed within the LAA for each VC for both the construction and dry operations phases in Volume 3A, with the unique effects of each phase recognized. Those assessments consider any past and present projects and physical activities in the LAA, and are assessed in a study area adequate to ensure the identification and characterization of effects directly attributable to the Project. The baseline state of the VCs in those assessments reflects the VC’s response to conditions in the LAA, and often also to conditions beyond the LAA. Therefore, these effects typically are representative of similar interacting effects more broadly in the region. The assessment of potential cumulative effects of the Project with past and present other projects and activities is accomplished by recognizing in the interactions table where such interactions may occur, and in consideration of the regional context described in section 1.1.5.

During construction and dry operations, the baseline conditions (past and present) are all those identified in Table 1-1 under the heading “past and present (have been carried out)”, and the future conditions are all those identified under the heading “Future (may or will be carried out)”. Most future projects and physical activities are identified by a specific project name and proponent.

A particularly unique situation occurs with the realignment of existing pipelines. While these, for completeness, have been itemized as a future physical activity in Table 1-1, they occur entirely within the PDA with that activity only a consequence of the Springbank Off-stream Reservoir Project (versus happening for other reasons by the owner of those pipelines). As such, the effects of these activities have already been accounted for, and adequately so from a cumulative effects perspective, by the residual effects assessment for construction (Volume 3A).

Given the above, the focus of the assessment of potential cumulative effects is on the potential interactions of the Project with each future project and physical activity because they have not yet been accounted for elsewhere in this EIA.

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1.1.6.2 Flood and Post-flood Operations

The assessment of flood and post-flood operations borrows much the same fundamental approach to assessing potential cumulative effects as for construction and dry operations. The following describes how the assessment of the flood and post-flood scenario differs:

1. The baseline for the assessment of effects for flood and post-flood operations is shifted to the conditions represented by the dry reservoir phase. As such, the Project has been constructed and is ready to mitigate a flood, if that occurs.
2. Predicting the year of a future flood is not possible. Currently, the Project is scheduled to be functionally operational (able to accommodate a 1:100-year flood) in the spring of 2021, and be completely constructed (able to accommodate the design flood) in the spring of 2022. A conservative approach was taken and cumulative effects for flood and post-flood operations assume that a design flood would occur in 2022 i.e., the earliest time at which the Project could accommodate a design flood. According to the project design, the reservoir would then be drained over a period of approximately 40 days; this draining is included in flood operations.
3. Most of the future projects would have been built by 2022, and so become part of the new baseline for this scenario; i.e., those projects and physical activities no longer are future (in 2022), but are past and present. Those projects and physical activities that in any way carry forward in time do not, however, have specific descriptive information available to further characterize effects. As such, little more can be done than to acknowledge that these projects and physical activities may in some way cause future effects. The four projects and physical activities for which this applies are:
 - The Community of Harmony - Stage 2 and 3 will be further developed but will remain within the same boundary for that development as was used for the construction and dry operations for the Project.
 - Upgrades to Highways 1, 8 and 22 are lacking specific details regarding the disturbance footprint and associated activities.
 - Rocky View County Springbank Master Drainage Plan is lacking specific details of physical projects and activities arising from this plan, which only implies that at some time in the future projects and physical activities may happen. Also, the Springbank Off-stream Reservoir Project PDA is outside and to the west of the Springbank Master Drainage Plan study area, each area occupying a separate drainage. As such, there is no hydraulic connectivity between the two areas. Therefore, this plan is not discussed further in the VC cumulative assessments.
 - City of Calgary is recognized largely for its general contribution to socio-economic effects in the region; specific projects and physical activities do not need to be identified. Therefore, this is not discussed further in the VC cumulative assessments.

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4. The major known and measurable change in this scenario, given what is described above, is therefore the changes of the Springbank Off-stream Reservoir Project itself; namely, the purposeful flooding of the reservoir to mitigate downstream effects during a flood. This has implications for example to regional availability of habitat when the reservoir contains diverted flood water, and to regional vegetation when the reservoir has been drained. This scenario includes three conditions regarding the presence and movement of water: full of water (to the extent of each flood), draining water, and drained of water.
5. Given the above, the focus of assessment of potential cumulative effects is focused on unique interactions that may occur, specific to each VC and effect, and focused on one or more of the conditions regarding the presence and movement of water.

1.2 CUMULATIVE EFFECTS ASSESSMENT – CONSTRUCTION AND DRY OPERATIONS

1.2.1 Air Quality and Climate

1.2.1.1 Project Residual Effects Likely to Act Cumulatively

The construction phase will result in exhaust emissions (that include GHG) from construction equipment and fugitive dust emissions from surface disturbance activities. In addition, nighttime construction activities will require artificial lighting. With the appropriate mitigation, these effects are found to be not significant.

The dry operations phase will be limited to periodic inspections and routine maintenance activities. Therefore, there are negligible interactions of the Project with air quality, light, and GHG emissions. As discussed in Volume 3A, Section 3.4, adverse residual effects during dry operations are not anticipated.

Table 1-2 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and activities.

With respect to cumulative effects during construction, the expected Project construction period of 275 days could be spread over a two to three calendar year period. Most of the construction is expected to occur during non-winter periods when the ground is not frozen or covered with snow. The future physical activities identified in Table 1-2 have construction activities that are also of limited duration. Emissions associated with the construction of the Bragg Creek Flood Mitigation, Calgary to Cochrane Trail and the Calgary South west ring road are not within the air quality LAA or RAA and are unlikely to overlap with Project emissions. Upgrades to Highways 1, 8 and 22 are expected to occur post- Project construction.). Other physical activities that occur in the air quality LAA or RAA, and could take place during the Project construction period, are the Community of Harmony and Bingham Crossing

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developments, NGTL West Path Rocky View Section pipeline and the realignment of existing pipelines and utilities located in the PDA for the Project.

Table 1-2 Interactions with the Potential to Contribute to Cumulative Effects on Air Quality and Climate, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Change in Air Quality	Change in Ambient Light	Change in Greenhouse Gases
Past and Present Projects and Physical Activities			
Agriculture	✓	-	-
Infrastructure	✓	✓	✓
Residential and Communities	✓	✓	✓
Recreation and Tourism	✓	✓	✓
City of Calgary	✓	✓	✓
Project-Related Physical Activities	✓	✓	✓
Future Physical Activities			
Bragg Creek Flood Mitigation	-	-	-
Calgary to Cochrane Trail - Phase 2 and 3	-	-	-
The Community of Harmony - Stage 2 and 3	✓	✓	✓
Bingham Crossing	✓	✓	✓
Upgrades to Highways 1, 8 and 22	-	-	-
Southwest Calgary Ring Road	-	-	-
Realignment of existing pipelines and utilities	✓	✓	✓
NGTL West Path Rocky View Section pipeline	✓	✓	✓
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	✓	✓	✓
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

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1.2.1.2 Changes in Air Quality

Cumulative Effect Pathways

During construction, products of combustion result from construction equipment and vehicular exhausts, and fugitive dust emissions result from surface disturbance activities. Oxides of nitrogen (NO_x) and fine particulate (PM_{2.5}) emissions result from equipment and vehicle exhausts. Particles of various size ranges (i.e., PM_{2.5} and TSP) result from surface disturbance activities that include the construction haul roads. Ambient air quality in the LAA will be influenced by emissions from the Project and from other future sources. The air quality assessment in Volume 3A, Section 3.0 explicitly considers contributions from the Project and other main sources in the LAA (i.e., TransCanada Highway (Highway 1), Highway 22, Highway 8, and the Springbank Road traffic; and a nearby compressor station). The air quality assessment also implicitly includes other sources (e.g., lower volume secondary roads and residential/commercial heating) through the inclusion of a background level. The background level is estimated from representative ambient air quality measurements.

Ambient concentrations downwind from each emission source are the greatest near the emission source and decrease with increasing distance from the source due to atmospheric dispersion processes. For short-term air quality changes, emission plumes from different sources will only align under limited wind direction conditions.

The Community of Harmony is 5 km northeast of the PDA. Emissions will result from construction activities that will be spread over a 15-year phased development period and from residential and local traffic emissions associated with each phase as it is completed and occupied. During the initial clearing, grading, and road construction phase, the emission profile is expected to be similar to that associated with the Project (i.e., diesel fueled construction equipment and fugitive dust emissions).

The Bingham Crossing development is 6 km northeast of the PDA. As with the Community of Harmony, the emission profile during the initial construction phase is expected to be similar to that associated with the Project. Once development is complete, the emissions will result from residential/commercial heating and local traffic.

The NGTL West Path Rocky View Section construction occurs during approximately a year, with intermittent equipment use along the right-of-way for the installation of a buried pipeline.

The realignment activities associated with existing pipelines and utilities will primarily occur within the PDA. The emission profile associated with these activities is also expected to be similar to that associated with the Project (i.e., diesel fueled construction equipment and fugitive dust emissions). These activities are expected to occur during the Project construction period.

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Mitigation for Cumulative Effects

Mitigation measures will be implemented to manage and reduce Project emissions during the construction phase. Monitoring will be implemented in conjunction with emission mitigation to provide an understanding of meteorological conditions and offsite concentrations, and determine the need for more rigorous mitigation. Monitoring will include the installation and operation of a meteorological tower and particulate matter (PM) monitoring equipment. Based on wind conditions and measured concentration levels, the most appropriate and effective mitigation options will be implemented to reduce emissions. Project mitigation measures are identified in Volume 3A, Section 3.4.3. No additional mitigation measures specific to cumulative effects are proposed.

Because the Community of Harmony will be developed and occupied in phases over an extended 15-year period, it is expected that the developer will manage construction emissions to reduce air quality changes in adjacent developed (i.e., occupied) phases. The Harmony earthworks contractor has implemented a 5-minute idling policy on large earth moving equipment; i.e., if a piece of equipment is sitting longer than 5 minutes, they turn the engine off (<http://liveinharmony.ca/vision-team/a-sustainable-vision/>). Bingham Crossing proposes to adopt LEED (Leadership in Energy and Environmental Design) certified building to increase energy efficiencies and reduce emissions (<https://www.rockyview.ca/Portals/0/Files/.../Planning/CS/.../CS-Bingham-Crossing.pdf>). It is expected that realignment activities associated with existing pipelines and utilities will follow emission management practices similar to those adopted by the Project.

Construction of the NGTL West Path Rocky View Section pipeline will include in its environmental management plan the adoption of best practices, including minimization of emissions from equipment.

Residual Cumulative Effects

Residual effects on ambient air quality due to the Project are discussed in Volume 3A, Section 3.4.4. Anticipated residual effects are based on air quality model predictions that include baseline and project emissions. Ambient background concentrations are added to the model predictions to account for smaller sources inside the LAA and other sources outside the LAA that are not explicitly included in the model simulations. The model predictions indicate a potential for high NO₂, PM_{2.5}, TSP, acrolein, formaldehyde, benzo(a)pyrene, and odourant concentrations at and near the PDA. During construction, an ambient air monitoring program and an odour complaint and management process is planned due to these predictions (i.e., an adaptive management plan).

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Relative to the Community of Harmony, construction emissions are expected to occur during the nominal two to three-year Project construction period. Existing emissions are implicitly accounted for by background modelling completed for the Project. An examination of Springbank Airport wind measurements (Volume 3A, Section 3.2.2, Figure 3-3) indicates the least frequent wind directions are from the northeast and southwest quadrants. This suggests limited potential for emissions from the Project to overlap with those from the Community of Harmony and Bingham Crossing. The emissions from the Community of Harmony will not materially change the predicted Project residual effects conclusions and the need for the adaptive management plan approach.

Emissions associated with the construction and development of Bingham Crossing are expected to be similar to, but on a smaller scale and for a shorter duration, those associated with the Community of Harmony. Therefore, Bingham Crossing will not materially change the predicted Project residual effects conclusions and the need for the adaptive management plan approach.

Emissions from the NGTL West Path Rocky View Section pipeline will be minor and intermittent, limited to some equipment as construction moves along the right-of-way.

The emissions associated with the realignment of existing pipelines and utilities activities are expected to be much smaller than the Project construction emissions. Because realignment activities occur primarily within the PDA and are relatively small and short term, emissions would not materially change the predicted Project residual effects conclusions and the need for the adaptive management plan approach.

1.2.1.3 Changes in Greenhouse Gas Emissions

Cumulative Effect Pathways

The Project construction equipment and vehicle exhausts are sources of greenhouse gas (GHG) emissions that are primarily carbon dioxide (CO₂) with smaller amounts of methane (CH₄) and nitrous oxide (N₂O). Other future projects (both inside and outside the LAA) associated with the combustion of fossil fuels also result in GHG emissions. The environmental effects associated with GHG emissions are on a global scale.

Mitigation for Cumulative Effects

The mitigation measures that reduce emissions from Project construction equipment and vehicle exhausts are also applicable for reducing project GHG emissions. No additional mitigation specific to cumulative effects is proposed.

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The community of Harmony is planning extensive landscaping with the planting of 17,500 trees which will sequester carbon from the atmosphere (<http://liveinharmony.ca/vision-team/guiding-principles/>). The Bingham Crossing conceptual plan indicates that trees will be used to provide visual barriers and enhance local pathways and trails (<https://www.rockyview.ca/Portals/0/Files/.../Planning/CS/.../CS-Bingham-Crossing.pdf>).

Residual Cumulative Effects

GHG emissions associated with other projects in the RAA have not been estimated since environmental effects associated with GHG emissions are on a global scale. The total estimated GHG emissions due to Project construction is 85 kt CO₂e, occurring over a period of two to three years. This is 0.03% of Alberta's 2014 GHG emission rate and 0.01% of the Canadian 2014 GHG emission rate. GHG emissions due to Project construction are expected to be irregular in frequency and low in magnitude. The contribution of the Project and the indicated future projects are small on a provincial, national and global context and would not contribute measurably to climate change.

1.2.1.4 Changes in Ambient Light

Cumulative Effect Pathways

Because Project construction activities are planned to occur 24 hours per day, lighting units will be used near locations where earthworks will take place and near roadway intersections. The maximum light trespass and glare at nearby receptors are less than guideline thresholds. The Project construction phase is not expected to have a substantial contribution to existing sky glow.

For the Community of Harmony, early construction phase activity associated with clearing, grading and road construction activity is not expected to be a 24-hour operation and, therefore, not associated with lighting; no cumulative effect is expected. Lighting will be associated with the home building and occupancy phases. Similar characteristics apply to Bingham Crossing.

The realignment activities associated with existing pipelines and utilities are expected to occur primarily during the day and, hence, will not have associated lighting concerns.

Mitigation for Cumulative Effects

The Project construction phase requires mobile lighting to provide a secure and safe working environment. Associated mitigation measures identified in limit potential effects on light trespass, glare, and sky glow. No additional mitigation measures specific to cumulative effects are proposed.

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The Community of Harmony proposes to use efficient lighting and street lamps (<http://liveinharmony.ca/vision-team/guiding-principles/>). Bingham Crossing also intends to reduce the effects of artificial lighting on the environment and the surrounding community (<https://www.rockyview.ca/Portals/0/Files/.../Planning/CS/.../CS-Bingham-Crossing.pdf>). On this basis, lighting associated with both developments are expected to employ appropriate design features to also reduce light trespass, glare, and sky glow.

Residual Cumulative Effects

Due to the separation distance between the community of Harmony and the Bingham Crossing development and the PDA, and the elevated land features between these two locations, the combined lighting is not expected to be additive.

1.2.1.5 Significance of Cumulative Effects

With the implementation of mitigation and monitoring programs, the residual effects of the Project on air quality are not significant. Given the limited potential for future projects to interact with the Project, either temporally or spatially, the residual cumulative environmental effect is also predicted to be not significant.

1.2.1.6 Project Contribution to Cumulative Effects

For the ambient air quality and ambient light components, adverse environmental effects due to the Project occur along and near the PDA boundary. The contribution of the other identified future projects at these locations is limited. The Project is anticipated to contribute more to the cumulative effect on air quality than the other identified future projects; however, it will be limited to duration of Project construction.

1.2.1.7 Prediction Confidence

Prediction confidence ranges from moderate to high. The level of confidence is high for estimated combustion emissions from the Project; however, emissions from other future sources have not been modelled because detailed information on activities is unavailable. Therefore, confidence in predictions for future activities is moderate.

1.2.2 Hydrogeology

1.2.2.1 Project Residual Effects Likely to Act Cumulatively

The Project has the potential to change groundwater quantity in and near the PDA because of local, shallow and temporary subsurface dewatering that might be required to facilitate construction of the diversion channel, dam and floodplain berm, low-level outlet works, bridge, excavation of borrow pits, and utility realignments.

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Modelling results indicate the Project is anticipated to have adverse residual effects, but not significant effects, on groundwater quantity. The duration of the effect due to construction dewatering would be short term because it will be limited to construction only.

Table 1-3 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and future physical activities.

Table 1-3 Interactions with the Potential to Contribute to Cumulative Effects on Hydrogeology, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in groundwater quantity (construction dewatering)
Past and Present Projects and Physical Activities	
Agriculture	-
Infrastructure	-
Residential and Communities	-
Recreation and Tourism	-
City of Calgary	-
Project-Related Physical Activities	✓
Future Physical Activities	
Bragg Creek Flood Mitigation	-
Calgary to Cochrane Trail - Phase 2 and 3	-
The Community of Harmony - Stage 2 and 3	-
Bingham Crossing Development	-
Upgrades to Highways 1, 8 and 22	-
Southwest Calgary Ring Road	-
Realignment of existing pipelines and utilities	-
NGTL West Path Rocky View Section pipeline	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES:	
✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects.	
- = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

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The Bragg Creek Flood Mitigation, Calgary to Cochrane Trail and the Southwest Calgary Ring Road are located outside the RAA defined for hydrogeology. As such no pathway for cumulative effects are anticipated.

Adverse residual effects on hydrogeology from the Project are anticipated to occur during the construction phase only and not during dry operation. It is anticipated that upgrades to Highway 1, 8 or 22 will occur after 2020. By that time most of the Project would be constructed and the remaining work would be above ground and concentrated at the berm structure. As such no pathway for cumulative effects on hydrogeology are anticipated.

The realignment of existing pipelines will occur within the PDA and the effects of these activities have been accounted for within the residual effects assessment for the Project.

Construction of the NGTL West Path Rocky View Section pipeline will involve a horizontal directional drill under the diversion channel. The implementation of industry best practice and the relatively minor size of the project will minimize any potential for effects on groundwater.

The Community of Harmony and the Bingham Crossing development have a limited overlap with the northeast perimeter of the RAA defined for hydrogeology. As noted above, Project effects on water quantity will be limited to the PDA and LAA and will be limited to construction. Construction activities at the Community of Harmony and the Bingham Crossing development may occur at the same time as Project construction and may interact with groundwater. However, given the distance of the two developments from the Project PDA and the duration of potential Project effects (construction only), the potential for cumulative effects on ground water quantity are negligible.

1.2.3 Surface Water Quality

1.2.3.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects, but the effects are not significant, on surface water quality because of changes in sediment levels and herbicide application. The effect of construction on water quality through change in suspended sediment concentration, considering construction mitigation measures and construction monitoring, is low in magnitude, restricted to the PDA, and short-term in duration. The effect of the Project construction on downstream water quality in Elbow River and Glenmore Reservoir is negligible, given that sediment concentrations would be monitored during construction and given the mitigation measures.

The effect of dry operation on water quality through herbicide application, considering the use of the Environmental Code of Practice for Pesticides, is low in magnitude, restricted to the LAA and short-term in duration. Given the very low frequency of herbicide detection in the watershed, the effect is reversible through dilution.

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Table 1-4 lists the projects that have the potential to act cumulatively with the residual environmental effects from the Project.

Table 1-4 Interactions with the Potential to Contribute to Cumulative Effects on Surface Water Quality, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Water Quality
Past and Present Projects and Physical Activities	
Agriculture	-
Infrastructure	-
Residential and Communities	-
Recreation and Tourism	-
City of Calgary	-
Project-Related Physical Activities	✓
Future Physical Activities	
Bragg Creek Flood Mitigation	-
Calgary to Cochrane Trail - Phase 2 and 3	-
The Community of Harmony - Stage 2 and 3	-
Bingham Crossing Development	-
Upgrades to Highways 1, 8 and 22	-
Southwest Calgary Ring Road	-
Realignment of existing pipelines and utilities	-
NGTL West Path Rocky View Section pipeline	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

The Calgary to Cochrane Trail is located outside the RAA (the Elbow River watershed) defined for surface water quality. No pathway for cumulative effects is anticipated.

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The Community of Harmony and Bingham Crossing development, have a limited overlap with the northern perimeter of the RAA defined for surface water quality. They are located a nominal 5-6 km from the PDA/LAA within which Project residual effects are predicted. Given the distance between the two developments and the PDA/LAA and the fact that standard industry mitigation and best management practices would be implemented at the developments, the potential for cumulative effects on surface water quality is considered negligible.

Potential upgrades to Highways 1, 8 and 22, and the realignment of existing pipelines and utilities will occur within and near the PDA. However, these projects will implement standard industry mitigation and best management and residual effects on surface water quality are not anticipated.

The Bragg Creek Flood Mitigation is located within the RAA (the Elbow River Watershed) defined for surface water quality. Primary construction of the Bragg Creek flood mitigation measures will occur between May 2018 and February 2019, with site reclamation and clean up occurring from May to November 2019. As such, the majority of instream works are anticipated to be complete before the Project commences construction (Q2, 2019). An Aquatic Environment Assessment was completed for the Bragg Creek Flood Mitigation in July 2017 (AMEC Foster Wheeler 2017a). The assessment detailed mitigation measures and best management practices that will be implemented during construction including: a sediment and erosion control plan, isolation of instream works, spill response and management, and guidelines for handling and treatment of building materials to prevent the release or leaching of substances into the water. With the implementation of such measures residual effects to surface water quality would not be anticipated. In the absence of residual effects on surface water quality there is no pathway for cumulative effects with the Project.

Construction of the NGTL West Path Rocky View Section pipeline will not affect surface water bodies.

The Southwest Calgary Ring road is located partially within the southeastern part of the RAA (the Elbow River watershed) defined for surface water quality. The environmental assessment completed for the Southwest Calgary Ring road determined that *"There will be no residual effects to surface water quality from the construction or operation of the SWCRR Project. Impacts to surface water quality during the construction and operations phase can be mitigated through Project design and measures outlined in the EPP, and the contractor's ESC and ECO plans"* (AMEC Environment and Infrastructure 2014). In the absence of residual effects on surface water quality there is no pathway for cumulative effects with the Project.

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1.2.4 Aquatic Ecology

1.2.4.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects, but not significant, on aquatic ecology from the permanent alteration or destruction of fish habitat during construction and dry operation.

Table 1-5 lists the projects that have the potential to act cumulatively with residual environmental effects from the Project.

Table 1-5 Interactions with the Potential to Contribute to Cumulative Effects on Aquatic Ecology, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Permanent Alteration of Fish Habitat	Destruction of Fish Habitat	Death of Fish
Past and Present Projects and Physical Activities			
Agriculture	-	-	-
Infrastructure	-	-	-
Residential and Communities	-	-	-
Recreation and Tourism	-	-	-
City of Calgary	-	-	-
Project-Related Physical Activities	✓	✓	-
Future Physical Activities			
Bragg Creek Flood Mitigation	✓	✓	-
Calgary to Cochrane Trail - Phase 2 and 3	-	-	-
The Community of Harmony - Stage 2 and 3	-	-	-
Bingham Crossing Development	-	-	-
Upgrades to Highways 1, 8 and 22	-	-	-
Southwest Calgary Ring Road	✓	✓	-
Realignment of existing pipelines and utilities	-	-	-
NGTL West Path Rocky View Section pipeline			
Rocky View County Springbank Master Drainage Plan			
City of Calgary			
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

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Both the Calgary to Cochrane Trail and the Community of Harmony development are located outside the RAA (the Elbow River watershed) defined for aquatic ecology. Therefore, no pathway for cumulative effects are anticipated.

Construction of the NGTL West Path Rocky View Section pipeline will not affect surface water bodies.

The Bingham Crossing Development, potential upgrades to Highways 1,8, and 22, and the realignment of existing pipelines and utilities would occur within the RAA. However, these projects will implement standard and accepted industry avoidance and mitigation measures, as well as applicable best management practices that will avoid and/or mitigate the potential for serious harm to fish or negative effects to the aquatic environment. Therefore, residual effects on aquatic ecology, through the permanent alteration or destruction of fish habitat, or the death of fish, are not anticipated.

1.2.4.2 Destruction of Fish Habitat and Permanent Alteration of Fish Habitat

Cumulative Effect Pathways

The two projects within the RAA with the potential to act cumulatively with the Project are the Bragg Creek Flood Mitigation and the Southwest Calgary Ring road (SWCRR). Both projects would likely have similar effect pathways on fish and fish habitat as those identified for the Project:

- release of deleterious substances
- alteration or loss of fish habitat
- flow disruption and blockage of fish passage during instream works

Mitigation for Cumulative Effects

Environmental protection will be managed during construction through Alberta Transportation's Environmental Construction Operations (ECO) Plan process (Alberta Transportation 2017). Measures to avoid and/or mitigate effects on aquatic ecology have been developed based on best management practices described in the Fish Habitat Manual (Alberta Transportation 2009), the COP for Watercourse Crossings (ESRD 2013), and DFO's *Measures to Avoid Causing Harm to Fish and Fish Habitat including Aquatic Species at Risk* (DFO 2016). Project specific mitigation measures include timing of activities, operation of machinery, handling of deleterious substances, erosion and sediment control, water management, stream isolation, reclamation, and structure operation and maintenance. No additional mitigation measures specific to cumulative effects are proposed.

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An Aquatic Environment Assessment (AMEC Foster Wheeler 2017a) completed for the Bragg Creek Flood Mitigation presents a suite of avoidance and mitigation measures adapted from DFO's *Measures to Avoid Causing Harm to Fish and Fish Habitat including Aquatic Species at Risk* (DFO 2016), which will be implemented during construction to avoid and/or mitigate potential effects on fish and fish habitat.

The SWCRR environmental assessment presents a suite of mitigation measures, including an EPP and Conceptual Channel Enhancement Plan (CEP), designed to mitigate potential effects on fish and fish habitat.

Residual Cumulative Effects

The Project will result in adverse residual effects during construction and dry operation within the PDA/LAA. The instream footprint of the Project, including temporary construction area within the bankfull of the Elbow River, is 4,550 m². This area includes the permanent diversion structure footprint in the bankfull of approximately 1,854 m², that would result in the permanent alteration of habitat. Approximately 300 m² of habitat in the unnamed tributary [ID1350] would be lost as a result of the Project.

The Project will not result in the death of fish that would threaten the long-term persistence or viability of aquatic species of management concern in the RAA because of proposed avoidance and mitigation measures implemented during the construction phase. During dry operations, it is expected that the risk to fish mortality would be equivalent to existing conditions in the Elbow River; therefore, the Project should not have an effect on the relative abundance or distribution of fish that support CRA fisheries in the Elbow River or SAR, such as bull trout that are found near the Project or cutthroat trout populations in the headwaters of the Elbow River, outside of the Project's area of effect.

The Project would result in the permanent alteration of 1,854 m² and the loss of 300 m² of fish habitat during construction and dry operations; however, the amount of fish habitat permanently affected or destroyed is relatively small compared to the availability of fish habitat remaining in the LAA, and would not affect the abundance or distribution of fish, including fish that support CRA fisheries and aquatic Species at Risk (SAR). The residual effects are unlikely to pose a long-term threat to the persistence or viability of a fish species in the Elbow River, including SAR.

The Bragg Flood Mitigation project will result in a total loss of 3,976 m² of fish habitat along the margins of the Elbow River (AMEC Foster Wheeler 2017a). The report concludes that *"If the mitigations, specifications, and the final offset plan, which will be approved by AEP and Fisheries and Oceans Canada, outlined within this report are followed, there should be no change to the productivity of the Elbow River or Bragg Creek"* (AMEC Foster Wheeler 2017a)

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The SWCRR will result in a total loss of 20,482 m² of fish habitat in the Elbow River (AMEC Environment and Infrastructure 2014). The environmental assessment completed for the Southwest Calgary Ring road determined that *“Residual effects to fish and fish habitat from the proposed SWCRR Project are predicted to be negligible to minor. Channel realignments at Elbow River and Fish Creek crossings will result in a permanent decrease in existing fish habitat. The CEP will mitigate habitat losses and ensure that the quantity and productive capacity of fish habitat in Elbow River and Fish Creek are sustained. Potential effects to fish and fish habitat resulting from construction are considered temporary, not extending past the reclamation phase of the Project. Mitigative techniques will be incorporated into the detailed design phases to ensure the Project is developed under the principles of the EPP. All other potential effects to fish and fish habitat identified in the assessment will be mitigated using EPP and engineering solutions during the detailed design”* (AMEC Environment and Infrastructure 2014).

The term “minor” above, in relation to residual effects, is defined as *“measured or estimated impact results in a noticeable effect on individuals of a population or on features of the VEC, but does not affect local populations, and effects are within the natural limits of variation. Effect can generally be mitigated using industry best practices”* (AMEC Environment and Infrastructure 2014).

The total net loss of habitat as a result of the Bragg Creek Flood Mitigation (3,976 m²), SWCRR (20,482 m²), and the Project is estimated to be 26,612 m² of fish habitat permanently altered or destroyed. Total habitat available with the Project RAA is estimated to be 3,000,000 m² based on the 67 km Elbow River in the LAA and the average 45 m channel width found in the 12 reaches of the baseline aquatic field assessment. The loss of habitat due to the three projects is therefore estimated to be 0.89 % of total available habitat.

With the successful implementation of avoidance and mitigation measures, the incremental contribution of the Bragg Creek Flood Mitigation and SWCRR combined with the Project’s predicted residual effect on fish habitat would be moderate in magnitude, occurring within the RAA and at multiple irregular events.

1.2.4.3 Significance of Cumulative Effects

The overall cumulative effects on fish and fish habitat attributable is considered minor because the amount of fish habitat affected is relatively small compared to the availability of fish habitat within the RAA. These effects are unlikely to pose a long-term threat to the persistence or viability of a fish species, including SAR, such as cutthroat trout and bull trout, in the RAA.

With the successful implementation of avoidance, mitigation, and environmental protection measures, the cumulative effects on aquatic ecology are predicted to be not significant.

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1.2.4.4 Contribution of the Project

The contribution of the Project to cumulative effects on aquatic ecology, when considered in a regional context with existing and future projects and activities, is expected to be minor because the amount of fish habitat permanently altered or lost is relatively small compared to the availability of fish habitat remaining.

1.2.4.5 Prediction Confidence

Prediction confidence of construction effects on the aquatic environment is high because the effects on the aquatic ecology from construction involving earthworks and instream work are generally well known and the avoidance and mitigation measures are well established. Although Elbow River flows are unaltered during dry operations, the prediction confidence of dry operation effects on aquatic ecology takes a precautionary approach and is moderate because of uncertainty related to fish movement, fish passage, and mitigation measures at the diversion structure to allow passage during dry operations.

1.2.5 Terrain and Soils

1.2.5.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on terrain and soils, but the effects are not significant.

Table 1-6 lists the projects that have the potential to act cumulatively with environmental effects from the Project.

Table 1-6 Interactions with the Potential to Contribute to Cumulative Effects on Terrain and Soils, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects	
	Change in Soil Quality and Quantity	Change in Terrain
Past and Present Projects and Physical Activities		
Agriculture	✓	-
Infrastructure	✓	-
Residential and Communities	✓	-
Recreation and Tourism	✓	-
City of Calgary	✓	-
Project-Related Physical Activities	✓	-

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Table 1-6 Interactions with the Potential to Contribute to Cumulative Effects on Terrain and Soils, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects	
	Change in Soil Quality and Quantity	Change in Terrain
Future Physical Activities		
Bragg Creek Flood Mitigation	-	-
Calgary to Cochrane Trail - Phase 2 and 3	-	-
The Community of Harmony - Stage 2 and 3	✓	-
Bingham Crossing Development	-	-
Upgrades to Highways 1, 8 and 22	✓	-
Southwest Calgary Ring Road	-	-
Realignment of existing pipelines and utilities	-	-
NGTL West Path Rocky View Section pipeline	✓	-
Rocky View County Springbank Master Drainage Plan	-	-
City of Calgary	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.		

The Bragg Creek Flood Mitigation, Calgary to Cochrane Trail, Bingham Crossing development and Southwest Calgary Ring road are located outside the RAA defined for terrain and soils. Therefore, no pathway for cumulative effects are anticipated. The realignment of existing pipelines and utilities will occur within the PDA.

Residual effects to terrain are isolated to specific project components due to engineering design (i.e., the diversion channel banks, off-stream dam and at the diversion structure). Similar effects on terrain would not be expected from the residential development of the Community of Harmony or highway upgrades. Therefore, no pathway for cumulative effects are anticipated.

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1.2.5.2 Changes in Soil Quality and Quantity

Cumulative Effect Pathway

Future projects with the potential to act cumulatively with the Project are the Community of Harmony, NGTL West Path Rocky View Section and upgrades to Highways 1, 8 and 22. These projects would be expected to have similar effect pathways to soil quality and quantity as those identified for the Project during construction (i.e., a change in agricultural land capability (LCC) and reclamation suitability due to admixing, compaction and rutting, and wind and water erosion).

Mitigation for Cumulative Effects

Specific project mitigation and monitoring measures are presented in Volume 3A, Section 9. No additional mitigation measures specific to cumulative effects are proposed.

Other future projects would be expected to implement standard mitigation measures during construction and operation.

Residual Cumulative Effects

Project infrastructure planned for the LAA would affect soils and the LCC of these soils. Construction and reclamation activities for infrastructure components may affect the agricultural land capability through changes to, for example, topsoil thickness. There would be a reduction in the areal extent of land rated as agricultural capability Class 3 (mode) by 7% of the LAA. This reduction is the result of the construction of the project components.

Development of the Community of Harmony will result in a change to the LCC of the development footprint; however, the site will not be under agricultural use after development.

Construction of the NGTL West Path Rocky View Section pipeline will include in its environmental management plan the adoption of best practices, including reducing effects on soils and soil reclamation. As such, given typical success of such reclamation for pipeline projects, minimal potential is anticipated for cumulative effects.

Upgrades to Highways 1, 8 and 22 may result in effects on soil quantity and quality. However, because upgrades would likely occur within the existing road right of way, changes to the LCC would be negligible, given that the land is not used for agricultural purposes.

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1.2.5.3 Significance of Cumulative Effects

A significant adverse residual effect is a change in soil quality or quantity resulting in a reduction in agricultural land capability that cannot be offset through mitigation or compensation measures.

Both the Community of Harmony and the Project will result in a reduction in agricultural land capability within the RAA. Private land needed for the Project will be acquired and landowners will be compensated appropriately. Therefore, cumulative effects on soil quality and quantity are not significant.

1.2.5.4 Project Contribution to Cumulative Effects

The contribution of the Project to cumulative effects on soil quality and quantity, when considered in a regional context with existing and future projects and activities, is expected to be limited. The amount of change to agricultural land capability (because of construction) is small compared to the availability of agricultural land remaining in the RAA.

1.2.5.5 Prediction Confidence

The prediction confidence in cumulative effects is moderate. There is a high degree of confidence for estimation of Project residual effects on soil quality and quantity. However, upgrades to Highways 1, 8 and 22 have not been confirmed in detail and therefore an assumption has been made in the assessment that upgrades would not require acquisition of agricultural land.

1.2.6 Vegetation and Wetlands

1.2.6.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on vegetation and wetlands, but the effects are not significant, during construction and operations. The residual effects are low in magnitude and limited to the PDA.

Table 1-7 lists the projects that have the potential to act cumulatively with residual environmental effects from the Project.

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Table 1-7 Interactions with the Potential to Contribute to Cumulative Effects on Vegetation and Wetlands, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects			
	Change in Landscape Diversity	Change in Community Diversity	Change in Species Diversity	Change in Wetland Function
Past and Present Projects and Physical Activities				
Agriculture	✓	✓	✓	✓
Infrastructure	✓	✓	✓	✓
Residential and Communities	✓	✓	✓	✓
Recreation and Tourism	✓	✓	✓	✓
City of Calgary	✓	✓	✓	✓
Project-Related Physical Activities	✓	✓	✓	✓
Future Physical Activities				
Bragg Creek Flood Mitigation	✓	✓	✓	✓
Calgary to Cochrane Trail - Phase 2 and 3	✓	✓	✓	✓
The Community of Harmony - Stage 2 and 3	✓	✓	✓	✓
Bingham Crossing Development	✓	✓	✓	✓
Upgrades to Highways 1, 8 and 22	✓	✓	✓	✓
Southwest Calgary Ring Road	-	-	-	-
Realignment of existing pipelines and utilities	-	-	-	-
NGTL West Path Rocky View Section pipeline	✓	✓	✓	✓
Rocky View County Springbank Master Drainage Plan	-	-	-	-
City of Calgary	-	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.				

The Southwest Calgary Ring road is located outside the RAA defined for vegetation and wetlands. Therefore, no pathway for cumulative effects are anticipated. The realignment of existing pipelines will occur within the PDA and the effects of these activities have been accounted for within the residual effects assessment for the Project.

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1.2.6.2 Changes in Landscape Diversity, Community Diversity, Species Diversity and Wetland Function

Cumulative Effect Pathways

Future projects with the potential to act cumulatively with the Project are the Bragg Creek Flood Mitigation, Calgary to Cochrane Trail, Community of Harmony (approximately 700 ha in the RAA), Bingham Crossing development (approximately 60 ha in the RAA), NGTL West Path Rocky View Section and upgrades to Highways 1, 8 and 22. These projects would be expected to have similar effects on vegetation and wetlands as those identified for the Project during construction (i.e., loss or alteration of vegetation and wetland species from stripping, or introduction and establishment of regulated weeds and non-native invasive species).

The Project will result in the loss of 178 ha of vegetation due to the permanent project structures and the temporary disturbance of approximately 168 ha of vegetation (borrow area, pipeline right of way, construction laydown area and soil stock pile locations). Although the extent of temporary disturbance is known, the actual location of these temporary construction areas has not yet been determined. Therefore, for the analysis on the effect on vegetation and wetlands, the entire construction footprint (734 ha) is used.

Mitigation for Cumulative Effects

Specific Project mitigation and monitoring measures include machinery operating guidelines, erosion and sediment control, and reclamation. No additional mitigation measures specific to cumulative effects are proposed.

Other future projects would be expected to implement standard mitigation measures and wetland compensation, as appropriate.

Residual Cumulative Effects

During construction, the Project would contribute to existing cumulative effects, however, the change in vegetation cover represents less than 1% of the upland and wetland cover types available in the RAA (Table 1-8). Similarly, during dry operations, the Project would contribute to a reduction in native upland by 0.1% (51.5 ha), with wetlands reclaimed back to existing conditions.

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Table 1-8 Change in Land Cover Types in the RAA

Vegetation Cover Type ^a	Existing Conditions		Construction				Dry Operations				Construction Planned Development Case				Dry Operations Planned Development Case			
	Amount of Cover Types in the RAA		Amount of Cover Types in the RAA		Change from Existing Conditions to Construction Phase		Amount of Cover Types in the RAA		Change from Existing Conditions to Dry Operations Phase		Amount of Cover Types in the RAA		Change from Existing Conditions to Construction Phase and Future Projects		Amount of Cover Types in the RAA		Change from Existing Conditions to Dry Operations Phase and Future Projects	
	Area (ha)	% RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA
Broadleaf Forest	10,181.7	9.9	10,181.7	9.9	0.0	0.0	10,181.7	9.9	0.0	0.0	10,181.7	9.9	0.0	0.0	10,181.7	9.9	0.0	0.0
Coniferous Forest	7,678.7	7.5	7,661.5	7.5	-17.3	-0.2	7,661.5	7.5	-17.3	-0.2	7,653.6	7.4	-25.2	-0.3	7,653.6	7.4	-25.2	-0.3
Mixed Forest	6,347.7	6.2	6,347.7	6.2	0.0	0.0	6,347.7	6.2	0.0	0.0	6,347.7	6.2	0.0	0.0	6,347.7	6.2	0.0	0.0
Shrubland	2,682.0	2.6	2,682.0	2.6	0.0	0.0	2,682.0	2.6	0.0	0.0	2,682.0	2.6	0.0	0.0	2,682.0	2.6	0.0	0.0
Grassland	27,950.6	27.2	27,660.0	26.9	-290.5	-1.0	27,916.3	27.2	-34.3	-0.1	27,114.8	26.4	-835.7	-3.0	27,359.6	26.6	-591.0	-2.1
Exposed Land	69.7	0.1	69.7	0.1	0.0	0.0	69.7	0.1	0.0	0.0	69.7	0.1	0.0	0.0	69.7	0.1	0.0	0.0
<i>Upland Subtotal</i>	<i>54,910.4</i>	<i>53.4</i>	<i>54,602.7</i>	<i>53.1</i>	<i>-307.8</i>	<i>-0.6</i>	<i>54,858.9</i>	<i>53.4</i>	<i>-51.5</i>	<i>-0.1</i>	<i>54,049.5</i>	<i>52.6</i>	<i>-860.9</i>	<i>-1.6</i>	<i>54,294.3</i>	<i>52.8</i>	<i>-616.1</i>	<i>-1.1</i>
Riparian	1,045.5	1.0	1,042.0	1.0	-3.5	-0.3	1,045.5	1.0	0.0	0.0	1,039.1	1.0	-6.4	-0.6	1,042.4	1.0	-3.1	-0.3
Wetland	973.5	0.9	973.4	0.9	-0.1	0.0	973.5	0.9	0.0	0.0	861.7	0.8	-111.7	-11.5	861.8	0.8	-111.6	-11.5
<i>Wetland Subtotal</i>	<i>2,019.0</i>	<i>2.0</i>	<i>2,015.4</i>	<i>2.0</i>	<i>-3.6</i>	<i>-0.2</i>	<i>2,019.0</i>	<i>2.0</i>	<i>0.0</i>	<i>0.0</i>	<i>1,900.8</i>	<i>1.8</i>	<i>-118.2</i>	<i>-5.9</i>	<i>1,904.3</i>	<i>1.9</i>	<i>-114.7</i>	<i>-5.7</i>
Water	1,674.2	1.6	1,667.0	1.6	-7.2	-0.4	1,673.1	1.6	-1.0	-0.1	1,656.4	1.6	-17.7	-1.1	1,662.6	1.6	-11.6	-0.7
<i>Water Subtotal</i>	<i>1,674.2</i>	<i>1.6</i>	<i>1,667.0</i>	<i>1.6</i>	<i>-7.2</i>	<i>-0.4</i>	<i>1,673.1</i>	<i>1.6</i>	<i>-1.0</i>	<i>-0.1</i>	<i>1,656.4</i>	<i>1.6</i>	<i>-17.7</i>	<i>-1.1</i>	<i>1,662.6</i>	<i>1.6</i>	<i>-11.6</i>	<i>-0.7</i>
Agriculture	21,499.8	20.9	21,262.9	20.7	-237.0	-1.1	21,260.7	20.7	-239.1	-1.1	21,072.9	20.5	-427.0	-2.0	21,070.7	20.5	-429.1	-2.0
Disturbed Land ^b	13,255.7	12.9	13,916.2	13.5	660.6	5.0	13,359.1	13.0	103.5	0.8	15,089.4	14.7	1,833.7	13.8	14,551.4	14.2	1,295.7	9.8
Tame Pasture or Hay	9,457.6	9.2	9,352.6	9.1	-105.0	-1.1	9,645.8	9.4	188.2	2.0	9,047.7	8.8	-409.9	-4.3	9,333.5	9.1	-124.2	-1.3
<i>Anthropogenic Subtotal</i>	<i>44,213.1</i>	<i>43.0</i>	<i>44,531.7</i>	<i>43.3</i>	<i>318.6</i>	<i>0.7</i>	<i>44,265.7</i>	<i>43.1</i>	<i>52.6</i>	<i>0.1</i>	<i>45,209.9</i>	<i>44.0</i>	<i>996.8</i>	<i>2.3</i>	<i>44,955.5</i>	<i>43.7</i>	<i>742.4</i>	<i>1.7</i>
Grand Total	102,816.7	100.0	102,816.7	100.0	0.0	0.0	102,816.7	100.0	0.0	0.0	102,816.7	100.0	0.0	0.0	102,816.7	100.0	0.0	0.0

NOTES:
^a Vegetation cover type was classified using ABMI's LCC spatial data (ABMI 2010). The cover types for the RAA differ from the LAA, where land units (ecosites) were used for spatial data.
^b Disturbed land in the construction and dry operations phase includes existing disturbance and the construction area footprint or dry operations Project structures. Disturbed land in the planned development case includes existing disturbance, the construction area footprint or dry operations Project structures, and future development footprints.

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All residual Project effects are expected to occur during construction, be low in magnitude and restricted to the PDA. No effects on plant species of management concern (SOMC) are expected.

Identified future projects would be expected to result in the removal of vegetation and potentially affected wetlands. However, the future projects are located primarily on disturbed or agricultural lands, which indicates that the potential for effects on native vegetation or SOMC would be limited.

The specific extent of vegetation loss as a result of other future projects is unknown. However; adopting a conservative assumption that the footprint of the Community of Harmony (approximately 700 ha) and the Bingham Crossing development (approximately 60 ha) resulted in direct total vegetation loss, in combination with the Project (direct loss 168 ha), the total vegetation lost as a result of the three projects combined would be 928 ha. This represents approximately 0.9% of the RAA.

The cumulative loss in vegetation cover from existing conditions during the construction of the Project with future projects applied is 1.6% (860.9 ha) for native upland cover and 5.9% (118.2 ha) for wetland cover. During dry operations, the cumulative loss in habitat from existing conditions when all future projects are applied is 1.1% (616.1 ha) for native upland cover and 5.7% (114.7 ha) for lowland cover.

With mitigation, the incremental contribution of future projects combined with the Project's predicted residual effect on vegetation and wetlands would be low in magnitude, occur within the RAA, and occur as multiple irregular events as future projects go forward.

1.2.6.3 Significance of Cumulative Effects

The cumulative effect on vegetation and wetlands attributable to the Project in combination with future projects is limited relative to the amount of vegetation and wetlands occurring throughout the RAA. The cumulative effect of the Project combined with future projects is not predicted to:

- threaten the long-term persistence or viability of a plant species or community in the RAA
- result in unreplaced loss or disturbances of wetlands that has not been given prior approval by Alberta Environment and Parks
- threaten the long-term availability of traditional use plants within the RAA

Therefore, with mitigation and environmental protection measures, the cumulative effects on vegetation and wetlands are predicted to be not significant.

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1.2.6.4 Project Contribution to Cumulative Effects

The contribution of the Project to cumulative effects, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because the amount of vegetation and wetlands lost or temporarily disturbed due to construction (311.4 ha) is relatively small (0.55%) compared to the availability of similar vegetation and wetlands remaining in the RAA (56,198 ha).

1.2.6.5 Prediction Confidence

Prediction confidence is moderate, because there is uncertainty regarding the abundance and distribution of plant and ecological communities of management concern in the LAA (beyond the PDA) and within the footprint of identified future projects.

1.2.7 Wildlife and Biodiversity

This section provides an assessment of potential cumulative effects on wildlife and biodiversity, organized in the following four parts:

1. identification of project residual effects likely to act cumulatively
2. an assessment of potential cumulative effects on wildlife in general, and biodiversity (sections 1.2.7.1)
3. an assessment of potential cumulative effects on migratory birds (section 1.2.7.2)
4. an assessment of potential cumulative effects on species at risk (section 1.2.7.3)

Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on wildlife and biodiversity, but the effects are not significant.

Table 1-9 lists the other projects that have the potential to act cumulatively with residual environmental effects from the Project.

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Table 1-9 Interactions with the Potential to Contribute to Cumulative Effects on Wildlife and Biodiversity, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects			
	Change in Habitat	Change in Movement	Change in Mortality Risk	Change in Biodiversity
Past and Present Projects and Physical Activities				
Agriculture	✓	✓	✓	✓
Infrastructure	✓	✓	✓	✓
Residential and Communities	✓	✓	✓	✓
Recreation and Tourism	✓	✓	✓	✓
City of Calgary	✓	✓	✓	✓
Project-Related Physical Activities	✓	✓	✓	✓
Future Physical Activities				
Bragg Creek Flood Mitigation	✓	✓	✓	✓
Calgary to Cochrane Trail - Phase 2 and 3	✓	✓	✓	✓
The Community of Harmony - Stage 2 and 3	✓	✓	✓	✓
Bingham Crossing Development	✓	✓	✓	✓
Upgrades to Highways 1, 8 and 22	✓	✓	✓	✓
Southwest Calgary Ring Road	-	-	-	-
Realignment of existing pipelines and utilities	✓	✓	✓	✓
NGTL West Path Rocky View Section pipeline	✓	✓	✓	✓
Rocky View County Springbank Master Drainage Plan	-	-	-	-
City of Calgary	-	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.				

The Southwest Calgary Ring Road is located outside the RAA defined for wildlife and biodiversity. Therefore, no pathway for cumulative effects with that project are anticipated.

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1.2.7.1 Cumulative Effects on Wildlife and Biodiversity

Change in Habitat

Cumulative Effect Pathways

Potential cumulative effects on wildlife habitat due to future projects and activities have similar effects as those identified for the Project. Specifically, vegetation removal associated with future projects has potential to result in direct habitat loss or alteration. In addition, construction activities also have potential to result in indirect effects due to sensory disturbance (e.g., noise and artificial light), which can reduce habitat effectiveness.

Mitigation for Cumulative Effects

Specific project mitigation and monitoring measures to reduce potential project effects on wildlife habitat are presented in Volume 3A, Section 11.4.2. These are viewed as sufficient to also address potential cumulative effects. Other future projects would be expected to implement industry standard mitigation measures as appropriate.

Residual Cumulative Effects

Existing and past developments have resulted in the loss of native grassland and mature forest, which has reduced habitat availability for some SOMC in the RAA, including key indicators: for example, Sprague's pipit, olive-sided flycatcher, and grizzly bear. Overall, agriculture, residential development, and recreation and transportation corridors have altered the current regional landscape and contributed to an existing cumulative effect on wildlife and biodiversity in the RAA. At existing conditions, 43.0% of the RAA contains anthropogenic lands (i.e., agriculture, disturbed land, and tame pasture or hay; Table 1-8). Due to the coarse-scale of the land cover mapping, tame grass-dominated areas (i.e., tame pasture), which provide suitable habitat for certain wildlife SOMC, are not distinguishable from alfalfa/clover-dominated areas (i.e., hay), which provide only marginal habitat for some wildlife SOMC.

During construction, the Project would contribute to existing cumulative effects, however, the change in habitat abundance represents less than 1% of the upland and wetland cover types available in the RAA (Table 1-8). Similarly, during dry operations, the Project would contribute to a reduction in native upland by 0.1% (51.5 ha), with wetlands reclaimed back to existing conditions (Table 1-8).

Vegetation removal associated with identified future projects will result in additional habitat loss and alteration as well as sensory disturbance, which will contribute to cumulative effects on SOMC in the RAA. However, future projects are predominantly located on disturbed or agricultural lands, which indicates these projects will not contribute substantially to residual cumulative effects on SOMC. Although some of the future projects also occur on grassland, the

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coarse scale of the land cover mapping likely overestimates the incremental habitat loss (545 ha; Table 1-8) at the Project construction phase as some of those lands (e.g., Harmony Development) would not provide suitable habitat for certain grassland dependent species (e.g., Sprague's pipit). Construction of the NGTL West Path Rocky View Section pipeline will include in its environmental management plan the adoption of best practices, including minimization of effects on soils and soil reclamation.

The future projects will also directly affect wetland and riparian habitats (Table 1-8), which will result in an incremental loss of habitat for wetland dependent species (e.g., northern leopard frog, sora) habitats). Overall, future projects will result in minimal changes to forest and shrubland cover types resulting in reduced residual cumulative effects for species such as bats or shrubland birds (e.g., house wren, eastern kingbird). Cumulative changes in habitat at dry operations are similar to the Project construction phase, but are reduced due to reclamation of vegetation for the Project as well as future projects.

The cumulative changes in habitat will largely affect wildlife species that might have suitable habitat within the proposed future project development lands (e.g., coyote); however, much of this land is already disturbed, which would reduce residual cumulative effects on SOMC. Similarly, habitat suitability immediately adjacent to Highway 22 for the six key indicators is rated as low to nil, primarily due to sensory disturbance (i.e., zone of influence). Therefore, upgrades to Highway 1, 22 and 8, south of Cochrane, will not result in an additional direct loss of high value wildlife habitats.

Some wildlife species and individuals might already have a relatively high tolerance for the existing traffic volumes on Highway 22, which may have resulted in some degree of habituation. However, upgrading the highway and increased future traffic volumes might result in additional sensory disturbance and reduced habitat effectiveness for some species. There are patches of mature trees adjacent to Highway 22 that provide potential nesting or perching habitat for raptors such as bald eagle, which has been reported roosting in balsam poplar trees within 250 m of Highway 22 (EBA 2010). Although some individuals tolerate vehicular traffic at this distance, increased traffic volumes along Highway 22 might result in further habitat displacement or avoidance by bald eagles due to additional sensory disturbance.

Other future projects that have potential to act cumulatively on wildlife habitat by contributing to additional sensory disturbance include construction of dikes along Elbow River for the Bragg Creek Flood Mitigation project, construction of the railway crossing along the Bow Bend pathway as part of Phase 2 of the Calgary to Cochrane Trail, construction of a pedestrian bridge over the Bow River near Cochrane (Phase 3), and construction of the NGTL pipeline. Although the pipeline relocations also have potential to result in cumulative effects associated with direct habitat loss and sensory disturbance, this physical activity will largely take place within the PDA where there would be existing ground disturbance.

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Overall, the potential for project residual effects to act cumulatively with the residual effects of future projects on wildlife habitat are relatively minor because the future developments do not contain high value wildlife habitat for many SOMC. Cumulative changes to habitat associated with future projects are unlikely to further affect the relative abundance or sustainability of species of management concern in the RAA. With mitigation, the residual cumulative effect on wildlife habitat would be low in magnitude, occur at multiple irregular events as future projects go forward and will be long-term in duration because future projects will result in permanent removal of vegetation.

Change in Movement

Cumulative Effects Pathways

Potential cumulative effects on wildlife movement due to future projects and activities have similar effects as those identified for the Project. Construction of the Harmony community development, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrades to Highway 1, 22 and 8 have potential to create physical barriers or sensory disturbance that might hinder wildlife movement in the RAA. Although future construction activities have potential to temporarily alter wildlife movement for SOMC in the short-term, longer term effects on wildlife movement (e.g., deer and elk) might occur, especially those associated with upgrades to Highway 22. The extent to which the Project and these future projects are perceived as hindrances (i.e., permeable, semi-permeable) or impermeable barriers would vary by wildlife species.

Mitigation for Cumulative Effects

Mitigation recommended for change in movement will reduce residual effects of the Project. Other future projects would be expected to implement industry standard mitigation measures to reduce the potential effects on wildlife movement in the RAA.

Residual Cumulative Effects

The existing road network has reduced landscape connectivity and created physical and sensory barriers, which has likely contributed to cumulative changes in wildlife movement in the RAA. Future development of the Harmony community, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrading of Highway 1, 22 and 8 have potential to contribute to existing cumulative effects on wildlife movement in the RAA. The Bragg Creek Flood Mitigation project is located along the Elbow River, which has been identified as a Key Wildlife and Biodiversity Zone (KWBZ). KWBZs provide potential ungulate winter range and facilitate wildlife movement along river valleys (ESRD 2015). However, because the Harmony community development, Bingham Crossing, and Bragg Creek Flood Mitigation project occur primarily on previously disturbed lands, the potential for these projects to contribute to a change in regional wildlife movement is limited.

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In addition, no observations of wildlife corridor movement along or crossing the Elbow river were observed for the Bragg Creek Flood Mitigation project (AMEC Foster Wheeler 2017b). The most likely species or individuals to use the KWBZ in the townsite would be those already habituated to human developments (e.g., deer or coyote; AMEC Foster Wheeler 2017b).

The extent to which upgrades to Highways 1, 22 and 8 will affect wildlife movement in the RAA would vary by wildlife species and future traffic volumes. Overall, upgrading Highways 1, 22 and 8 is more likely to have a relatively greater potential cumulative effect on large mammals (e.g., elk, deer) as well as less mobile species (e.g., amphibians) than the Project and other developments, because increased traffic volumes might result in incremental sensory disturbance and altered movement patterns. Activity from the NGTL West Path Rocky View Section pipeline will be minor and intermittent, limited to some equipment as construction moves along the right-of-way.

With mitigation, the residual cumulative effect of future activities combined with the Project on wildlife movement would be moderate in magnitude, occur at multiple irregular events as future projects go forward and would be long-term in duration. Upgrading Highways 1, 22 and 8 would result in a continuous residual cumulative effect on wildlife movement in the RAA.

Change in Mortality Risk

Cumulative Effects Pathways

Potential cumulative effects on wildlife mortality risk due to future projects and activities have similar effects as those identified for the Project. Construction of future projects would include vegetation removal and ground disturbance, which can result in the physical destruction of wildlife habitat features (e.g., nests, dens, roosts) and increase mortality risk for wildlife. Increased road development and traffic volumes associated with future projects, such as upgrades to Highway 1, 22 and 8, has potential to result in increased animal-vehicle collisions.

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk will reduce residual effects of the Project. Although the specific mitigation measures that would be implemented for future projects are unknown, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to SOMC, including migratory birds.

Residual Cumulative Effects

The existing road network has resulted in animal-vehicle collisions that have contributed to past and existing cumulative effects on wildlife mortality in the RAA (Alberta Transportation 2017). Although the Project will result in a low mortality risk during construction, upgrading Highway 22

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will contribute to a somewhat higher increase in mortality risk during operation, especially for large mammals such as deer and elk. This contribution to cumulative effects might be most pronounced in riparian areas that intersect Highway 22 (e.g., Elbow River, other creeks) where deer and elk are more likely to occur and possibly attempt to cross the expanded highway.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on mortality risk would be moderate in magnitude and occur at multiple irregular events as future projects go forward. Although cumulative effects on mortality risk would be short-term in duration because cumulative effects are limited to the construction phase, upgrading Highways 1, 22 and 8 would result in long-term effects on mortality risk.

Change in Biodiversity

Cumulative Effects Pathways

Potential cumulative effects on biodiversity due to future projects and activities have similar effects as those identified for the Project. During construction, future projects and activities have potential to change biodiversity due to changes in species, community, and landscape diversity. Landscape diversity can be affected through habitat fragmentation, patch isolation and edge effects.

Mitigation for Cumulative Effects

Mitigation recommended for change in biodiversity will reduce residual effects of the Project. Other future projects would be expected to implement industry standard mitigation measures to reduce their potential effects on wildlife habitat, movement and mortality risk, which will affect biodiversity.

Residual Cumulative Effects

Past and existing land use activities have contributed cumulatively to changes in ecological processes (e.g., species interactions, fragmentation, connectivity), which have affected species and landscape diversity in the RAA. Although Project residual effects combined with future projects and activities would contribute incrementally to cumulative effects on biodiversity, the Project's contribution is expected to be relatively minor. Mitigation and adherence to best management practices are expected to reduce potential contributions of these projects to cumulative effects and are not expected to threaten the sustainability or viability of SOMC, including key indicators, in the RAA.

With mitigation, the incremental contribution of future activities combined with the Project's predicted residual effect on biodiversity would be low in magnitude and occur at multiple irregular events as future projects go forward and would be long-term in duration.

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Significance of Cumulative Effects

The cumulative effects on wildlife and biodiversity attributable to the Project as well as all other future projects and activities is considered minor because most of the lands affected are previously disturbed, and do not provide high suitability habitat for SOMC, including species at risk. Future activities combined with the Project's predicted effects on habitat, movement and mortality risk will not threaten the long-term sustainability of wildlife in the RAA.

With mitigation and environmental protection measures, the cumulative effects on wildlife and biodiversity are predicted to be not significant.

Project Contribution to Cumulative Effects

The contribution of the Project to cumulative effects on wildlife and biodiversity, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because a large portion of the project construction area contains agricultural lands that do not provide high suitability wildlife habitat for SOMC. Although there will be small areas of wildlife habitat directly and indirectly affected, the Project's contribution to residual cumulative effects is not expected to measurably affect the abundance or sustainability of wildlife in the RAA because the footprint of the Project's permanent structures is small relative to the remaining habitats available in the RAA.

The contribution of the Project to cumulative increases in wildlife mortality risk is considered minor because of project-specific mitigation, short-term duration of construction activity, and relatively low human use (i.e., maintenance activities) during dry operations. Although the Project's permanent structures will alter wildlife movement for certain SOMC (e.g., elk), the contribution to cumulative effects is not expected to result in a change in the long-term sustainability of wildlife in the RAA.

Prediction Confidence

Prediction confidence for residual cumulative effects on wildlife and biodiversity is considered medium. Although the quality and quantity of baseline information used to predict Project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of wildlife within the RAA, as well as specific mitigation measures to be implemented by other future projects.

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1.2.7.2 Cumulative Effects on Migratory Birds

Change in Habitat

Cumulative Effects Pathways

Potential cumulative effects on migratory bird habitat due to future projects and activities have similar effects as those identified for the Project. Specifically, vegetation removal associated with future projects has potential to result in direct habitat loss or alteration. In addition, construction activities also have potential to result in indirect effects due to sensory disturbance (e.g., noise and artificial light), which can reduce habitat effectiveness.

Mitigation for Cumulative Effects

Specific mitigation and monitoring measures to reduce potential Project effects on migratory bird habitat are presented in Volume 3A, Section 11.4.2. Other future projects would be expected to implement industry standard mitigation measures, as appropriate.

Residual Cumulative Effects

Existing and past developments have resulted in the loss of native grassland and mature forest, which has reduced habitat availability for some migratory and non-migratory birds in the RAA. Overall, agriculture, residential development, and recreation and transportation corridors have altered the current regional landscape and contributed to an existing cumulative effect on migratory and non-migratory birds in the RAA. At existing conditions, 43.0% of the RAA contains anthropogenic lands (i.e., agriculture, disturbed land, and tame pasture or hay; Table 1-8). Due to the coarse-scale of the land cover mapping, tame grass-dominated areas (i.e., tame pasture), which provide suitable habitat for certain migratory birds, are not distinguishable from alfalfa/clover-dominated areas (i.e., hay), which provide only marginal habitat for some migratory birds.

During construction, the Project would contribute to existing cumulative effects, however, the change in habitat abundance represents less than 1% of the upland and wetland cover types available in the RAA (Table 1-8). Similarly, during dry operations, the Project would contribute to a reduction in native upland by 0.1% (51.5 ha), with wetlands reclaimed back to existing conditions (Table 1-8).

Vegetation removal associated with identified future projects will result in additional habitat loss and alteration as well as sensory disturbance, which will contribute to cumulative effects on migratory birds in the RAA. However, future projects are located on disturbed or agricultural lands, which indicates these projects will not contribute substantially to residual cumulative effects on migratory birds (see Table 1-8). Although future projects also occur on grassland, the coarse scale of the land cover mapping likely overestimates the incremental habitat loss

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(545 ha) at the project construction phase as some of those lands (e.g., Harmony Development) would not provide suitable habitat for certain grassland dependent species (e.g., Sprague's pipit).

Future projects will also directly affect wetland and riparian habitats, which will result in an incremental loss of habitat for wetland dependent migratory birds (e.g., rails, waterfowl). Overall, future projects will result in minimal changes to forest and shrubland cover types resulting in reduced residual cumulative effects for migratory birds dependent on forest (e.g., olive-sided flycatcher, Baltimore oriole, white-throated sparrow) and shrubland (e.g., house wren, loggerhead shrike). Cumulative changes in habitat at dry operations are similar to the Project construction phase, but are reduced due to reclamation of vegetation for the Project as well as future projects (see Table 1-8).

The cumulative changes in habitat will largely affect migratory birds that might have suitable habitat within the proposed future project development lands (e.g., gulls); however, much of this land is already disturbed, which would reduce residual cumulative effects on bird SOMC. Similarly, habitat suitability immediately adjacent to Highway 22 for the three bird key indicators is rated as low to nil, primarily due to existing sensory disturbance (i.e., zone of influence). Therefore, upgrades to Highway 1, 22 and 8, south of Cochrane, will not result in an additional direct loss of high value wildlife habitats.

Some migratory bird species and individuals might already have a relatively high tolerance for the existing traffic volumes on Highway 22, which may have resulted in some degree of habituation (Gaudet 2013; Ludlow et al. 2015). However, upgrading the highway and increased future traffic volumes might result in additional sensory disturbance and reduced habitat effectiveness for other migratory bird species (Bayne et al. 2008; Gaudet 2013; Ludlow et al. 2015). There are patches of mature trees adjacent to Highway 22 that provide potential nesting or perching habitat for non-migratory birds (e.g., raptors; see Volume 4, Appendix H, Wildlife and Biodiversity Technical Data Report, Section 3.4) such as bald eagle, which has been reported roosting in balsam poplar trees within 250 m of Highway 22 (EBA 2010). Although some individuals tolerate vehicular traffic at this distance, increased traffic volumes along Highway 22 might result in further habitat displacement or avoidance by raptors due to additional sensory disturbance.

Other future projects that have potential to act cumulatively on wildlife habitat by contributing to additional sensory disturbance include construction of dikes along Elbow River for the Bragg Creek Flood Mitigation project, construction of the railway crossing along the Bow Bend pathway as part of Phase 2 of the Calgary to Cochrane Trail, construction of a pedestrian bridge over the Bow River near Cochrane (Phase 3), and construction of the NGTL pipeline. Although the pipeline relocations also have potential to result in cumulative effects associated with direct habitat loss and sensory disturbance, this physical activity will largely take place within the PDA where there would be existing ground disturbance.

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Overall, the potential for project residual effects to act cumulatively with the residual effects of future projects on migratory and non-migratory bird habitat are relatively minor because the future developments do not contain high value habitat for bird SOMC. Cumulative changes to habitat associated with future projects are unlikely to further affect the relative abundance or sustainability of migratory birds in the RAA. With mitigation, the residual cumulative effect on migratory and non-migratory bird habitat would be low in magnitude, occur at multiple irregular events as future projects go forward, and will be long-term in duration because future projects will result in permanent removal of vegetation.

Change in Movement

Cumulative Effects Pathways

Potential cumulative effects on migratory bird movement due to future projects and activities have similar effects as those identified for the Project. Construction of the Harmony community development, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrades to Highway 1, 22 and 8 have limited potential to hinder migratory bird movement in the RAA, because none of the future projects involve the construction of tall structures (e.g., transmission lines, wind turbines, tall buildings) that birds would have to move around. The construction of the pedestrian bridge across the Bow River for Phase 3 of the Calgary to Cochrane Trail has potential to alter movement of waterbirds that use the river.

Mitigation for Cumulative Effects

There are no mitigation measures recommended for change in movement to migratory birds.

Residual Cumulative Effects

The existing road network has reduced landscape connectivity and created physical and sensory barriers, which has likely contributed to cumulative changes in terrestrial wildlife movement in the RAA. Because birds can fly over roads and structures, future development of the Harmony community development, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrades to Highway 1, 22 and 8 have limited potential to hinder migratory bird movement in the RAA. None of the future projects would be at heights that might interact with bird migration patterns or flyways. The pedestrian bridge across the Bow River for Phase 3 of the Calgary to Cochrane Trail has potential to alter local movement of waterbirds that use the river; however, most birds are likely to fly under or over the structure.

The residual cumulative effect of future activities combined with the Project on wildlife movement would be low in magnitude, occur at multiple irregular events as future projects go forward and would be long-term in duration.

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Change in Mortality Risk

Cumulative Effects Pathways

Potential cumulative effects on migratory bird mortality risk due to future projects and activities have similar effects as those identified for the Project. Construction of future projects would include vegetation removal and ground disturbance, which can result in the physical destruction of bird nests. Although no tall structures are expected to be built that predatory non-migratory birds such as raptors would use as hunting perches, vegetation removal associated with future projects has potential to increase the amount of edge habitat in the RAA, possibly increasing predation risk.

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk will reduce residual effects of the Project. Although the specific mitigation measures are unknown that would be implemented for future projects, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to migratory birds.

Residual Cumulative Effects

Pre-construction bird nest surveys and the application of timing and setback distances for nests found would allow for cumulative effects to be reduced for migratory birds.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on migratory bird mortality risk would be low in magnitude and occur at multiple irregular events as future projects go forward. Cumulative effects on mortality risk would be short term in duration because cumulative effects are limited to the construction phase.

Significance of Cumulative Effects on Migratory Birds

The cumulative effects on migratory birds attributable to the Project as well as all other future projects and activities is considered minor because most of the lands affected are previously disturbed, and do not provide high suitability habitat for migratory bird SOMC. Future activities combined with the Project's predicted effects on habitat, movement and mortality risk will not threaten the long-term sustainability of migratory birds in the RAA.

With mitigation and environmental protection measures, the cumulative effects on migratory birds are predicted to be not significant.

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Project Contribution to Cumulative Effects on Migratory Birds

The contribution of the Project to cumulative effects on migratory birds, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because a large portion of the construction area for the Project contains agricultural lands that do not provide high suitability habitat for migratory bird SOMC. Although there will be small areas of wildlife habitat directly and indirectly affected, the Project's contribution to residual cumulative effects is not expected to measurably affect the abundance or sustainability of migratory birds in the RAA because the footprint of the Project's permanent structures is small relative to the remaining habitats available in the RAA.

The Project's permanent structures would not alter migratory bird movement. The contribution of the Project to cumulative increases in migratory bird mortality risk is considered minor because of project-specific mitigation, short-term duration of construction activity, and relatively low human use (i.e., maintenance activities) during dry operations. Therefore, the Project's contribution to cumulative effects is not expected to result in a change in the long-term sustainability of migratory birds in the RAA.

Prediction Confidence for Migratory Birds

Prediction confidence for residual cumulative effects on migratory birds is considered medium. Although the quality and quantity of baseline information used to predict project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of migratory birds within the RAA, as well as specific mitigation measures to be implemented by other future projects.

1.2.7.3 Cumulative Effects on Species at Risk

Species-specific information regarding potential Project effects on federally listed species at risk and those species listed by COSEWIC are provided in Volume 3A and Volume 3B. The 22 species at risk are:

- horned grebe
- western grebe
- yellow rail
- long-billed curlew
- red knot
- short-eared owl
- common nighthawk
- peregrine falcon
- olive-sided flycatcher
- loggerhead shrike
- bank swallow

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- barn swallow
- Sprague's pipit
- Baird's sparrow
- bobolink
- rusty blackbird
- little brown myotis
- grizzly bear
- American badger
- western toad
- northern leopard frog
- western tiger salamander

During construction and dry operations, residual effects of the Project on species at risk habitat, movement and mortality risk have potential to interact cumulatively with future projects which are discussed below.

Change in Habitat

Cumulative Effects Pathways

Potential cumulative effects on wildlife habitat for species at risk due to future projects and activities have similar effects as those identified for the Project. Specifically, vegetation removal associated with future projects has potential to result in direct habitat loss or alteration. In addition, construction activities also have potential to result in indirect effects due to sensory disturbance (e.g., noise and artificial light), which can reduce habitat effectiveness.

All native cover types in the RAA provide potential breeding and foraging habitat for species at risk. Table 1-10 provides a summary of habitat associations for species at risk likely to occur in the RAA.

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Table 1-10 Species at Risk with Potential to Occur in the RAA and Their Associated Vegetation Cover Type

Vegetation Cover Type ^a	Species at Risk ^b
Broadleaf Forest	Little brown myotis, American badger
Coniferous Forest	Olive-sided flycatcher, rusty blackbird, little brown myotis
Mixed Forest	Olive-sided flycatcher, rusty blackbird, little brown myotis, grizzly bear
Shrubland	Loggerhead shrike
Grassland	Long-billed curlew, short-eared owl, common nighthawk, peregrine falcon, Sprague's pipit, Baird's sparrow, bobolink, grizzly bear, American badger
Exposed Land	N/A
Water	Western grebe, red knot
Wetland	Horned grebe, yellow rail, rusty blackbird, western toad, northern leopard frog, western tiger salamander
Riparian	Bank swallow, barn swallow, grizzly bear, peregrine falcon
Agriculture ^c	Long-billed curlew, rusty blackbird, American badger
Tame Pasture or Hay ^d	Long-billed curlew, short-eared owl, common nighthawk, bobolink, American badger
Disturbed Land ^c	Barn swallow, little brown myotis
<p>NOTES:</p> <p>^a Vegetation cover type was classified using ABMI's LCC spatial data (ABMI 2010).</p> <p>^b Some species at risk will have more than one habitat association for breeding and/or foraging.</p> <p>^c Agriculture and disturbed land typically provide low to nil habitat suitability for most SOMC; however, some SOMC are able to forage in cultivated land, and others can use anthropogenic structures (e.g., houses, bridges, etc.) for roosting or nesting.</p> <p>^d Due to the coarse-scale of the land cover mapping, tame grass-dominated areas (which provide suitable habitat for certain SOMC) are not distinguishable from alfalfa/clover-dominated areas (which provide only marginal habitat for some SOMC).</p>	

Mitigation for Cumulative Effects

Specific Project mitigation and monitoring measures to reduce potential Project effects on wildlife habitat for species at risk are presented in Volume 3A, Section 11.4.2. Other future projects would be expected to implement industry standard mitigation measures, as appropriate.

Residual Cumulative Effects

Existing and past developments have resulted in the loss of native grassland and mature forest, which has reduced habitat availability for some species at risk in the RAA, including Sprague's pipit, Baird's sparrow, olive-sided flycatcher, and grizzly bear. Wetlands are also limited on the



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landscape, with only 0.9% available in the RAA (Table 1-8). Species at risk that depend on wetlands for breeding are shown in Table 1-10. Overall, agriculture, residential development, and recreation and transportation corridors have altered the current regional landscape and contributed to an existing cumulative effect on species at risk in the RAA. At existing conditions, 43.0% of the RAA contains anthropogenic lands (i.e., agriculture, disturbed land, and tame pasture or hay; Table 1-8). Due to the coarse-scale of the land cover mapping, tame grass-dominated areas (i.e., tame pasture), which provide suitable habitat for certain species at risk (e.g., long-billed curlew), are not distinguishable from alfalfa/clover-dominated areas (i.e., hay), which provide only marginal habitat for some species at risk (e.g., bobolink). Cultivated lands are not suitable breeding habitat for many wildlife species; however, some species at risk such as rusty blackbird (Avery 2013) and long-billed curlew (Dugger and Dugger 2002), still use cultivated lands for forage.

During construction, the Project would contribute to existing cumulative effects, however, the change in habitat abundance represents less than 1% of the upland and wetland cover types available in the RAA (Table 1-8). Similarly, during dry operations, the Project would contribute to a reduction in native upland by 0.1% (51.5 ha), with wetlands reclaimed back to existing conditions.

Vegetation removal associated with identified future projects will result in additional habitat loss and alteration as well as sensory disturbance, which will contribute to cumulative effects on species at risk in the RAA. However, future projects are predominantly located on disturbed or agricultural lands, which indicates these projects will not contribute substantially to residual cumulative effects on species at risk (see Table 1-8). Although future projects also occur on grassland, the coarse scale of the land cover mapping likely overestimates the incremental habitat loss (545 ha) at the Project construction phase as some of those lands (e.g., Harmony Development) would not provide suitable habitat for certain grassland dependent species. Future projects will also directly affect wetland and riparian habitats, which will result in an incremental loss of habitat for wetland dependent species. Overall, future projects will result in minimal changes to forest and shrubland cover types resulting in reduced residual cumulative effects for species at risk dependent on these habitats such as little brown myotis or loggerhead shrike. Cumulative changes in habitat at dry operations are similar to the Project construction phase, but are reduced due to reclamation of vegetation for the Project as well as future projects.

The cumulative changes in habitat will largely affect species at risk that might have suitable habitat within the proposed future project development lands such as barn swallow, little brown myotis, and American badger, which are able to reside in an anthropogenic-modified landscape; however, much of this land is already disturbed, which would reduce residual cumulative effects on other species at risk. Similarly, habitat suitability immediately adjacent to Highway 22 for the six key indicators (four of these are species at risk) is rated as low to nil, primarily due to existing sensory disturbance (i.e., zone of influence). Therefore, upgrades to

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Highway 1, 22 and 8, south of Cochrane, will not result in an additional direct loss of high value wildlife habitats.

Some species at risk and individuals might already have a relatively high tolerance for the existing traffic volumes on Highway 22, which may have resulted in some degree of habituation. Barn swallows can nest in a variety of anthropogenic structures (e.g., buildings, culverts) and along highways (Brown and Brown 1999). Barn swallow nests were observed along Highway 22 under a culvert (see Volume 4, Appendix H, Wildlife and Biodiversity Technical Data Report, Section 3.8). However, upgrading the highway and increased future traffic volumes might result in additional sensory disturbance and reduced habitat effectiveness for other species at risk, further displacing them.

Change in Movement

Cumulative Effects Pathways

Potential cumulative effects on wildlife movement for species at risk due to future projects and activities have similar effects as those identified for the Project. Construction of the Harmony community development, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrades to Highway 1, 22 and 8 have potential to create physical barriers or sensory disturbance that might hinder terrestrial wildlife movement in the RAA for species at risk such as grizzly bear, American badger, western toad, northern leopard frog, and western tiger salamander. Potential cumulative effects on bird and bat species at risk movement due to future projects and activities are limited in that birds and bats are able to fly over structures; no tall structures are anticipated to be constructed such that birds and bats would have to fly around them.

Although future construction activities have potential to temporarily alter wildlife movement for species at risk in the short-term, longer term effects on wildlife movement might occur, especially those associated with upgrades to Highway 22 (e.g., amphibian species at risk). The extent to which the Project and these future projects are perceived as hindrances (i.e., permeable, semi-permeable) or impermeable barriers would vary by species.

Mitigation for Cumulative Effects

Mitigation recommended for change in movement will reduce residual effects of the Project. Other future projects would be expected to implement industry standard mitigation measures to reduce the potential effects on wildlife movement for species at risk in the RAA.

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Residual Cumulative Effects

The existing road network has reduced landscape connectivity and created physical and sensory barriers, which has likely contributed to cumulative changes in wildlife movement in the RAA. Future development of the Harmony community, Bingham Crossing, flood mitigation dikes in Bragg Creek, and upgrading of Highway 1, 22 and 8 have potential to contribute to existing cumulative effects on terrestrial wildlife movement in the RAA for species at risk such as grizzly bear, American badger, western toad, northern leopard frog, and western tiger salamander. Elk is not a species at risk, but is considered a species of traditional importance to Indigenous communities and is used as a key indicator. Future developments have a greater potential to contribute to existing cumulative effects on elk movement in the RAA.

The Bragg Creek Flood Mitigation project is located along Elbow River, which has been identified as a Key Wildlife and Biodiversity Zone (KWBZ). KWBZs provide potential ungulate winter range as well as facilitate wildlife movement along river valleys (ESRD 2015). However, because the Harmony community development, Bingham Crossing, and Bragg Creek Flood Mitigation projects occur primarily on previously disturbed lands, the potential for these projects to contribute to a change in regional wildlife movement for species at risk is limited. In addition, no observations of wildlife corridor movement along or crossing the river were observed for the Bragg Creek Flood Mitigation project (AMEC Foster Wheeler 2017b). The most likely species or individuals to use the KWBZ in the townsite would be those already habituated to human developments (e.g., deer or coyote; AMEC Foster Wheeler 2017b).

The extent to which upgrades to Highways 1, 22 and 8 will affect wildlife movement for species at risk in the RAA would vary by species and future traffic volumes. Overall, upgrading Highways 1, 22 and 8 is more likely to have a relatively greater potential cumulative effect on less mobile species at risk (e.g., amphibians) as well as the more common non-species at risk (e.g., deer and elk) than the effects from the Project and other developments because increased traffic volumes might result in incremental sensory disturbance and altered movement patterns.

With mitigation, the residual cumulative effect of future activities combined with the Project on wildlife movement for species at risk that move on the ground would be moderate in magnitude, but low in magnitude for bird and bat species at risk. Residual cumulative effects would occur at multiple irregular events as future projects go forward and would be long-term in duration. Upgrading Highways 1, 22 and 8 would result in a continuous residual cumulative effect on wildlife movement for mammal and amphibian species at risk in the RAA.

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Change in Mortality Risk

Cumulative Effects Pathways

Potential cumulative effects on wildlife mortality risk for species at risk due to future projects and activities have similar effects as those identified for the Project. Construction of future projects would include vegetation removal and ground disturbance, which can result in the physical destruction of wildlife habitat features (e.g., nests, dens, roosts) and increase mortality risk for wildlife species at risk. Increased road development and traffic volumes associated with future projects, such as upgrades to Highway 1, 22 and 8, has potential to result in increased animal-vehicle collisions for mammal species at risk.

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk will reduce residual effects of the Project. Although the specific mitigation measures that would be implemented are unknown for future projects, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to species at risk.

Residual Cumulative Effects

The existing road network has resulted in animal-vehicular collisions that have contributed to past and existing cumulative effects on wildlife mortality in the RAA (Alberta Transportation 2017). Although the Project will result in a low mortality risk during construction, upgrading Highway 22 will contribute to a somewhat higher increase in mortality risk during operation, especially for non-species at risk such as deer and elk. This contribution to cumulative effects might be most pronounced in riparian areas that intersect Highway 22 (e.g., Elbow River, other creeks) where animals are more likely to occur and possibly attempt to cross the expanded highway. The majority of animal-vehicular collisions involve ungulates. No species at risk, such as grizzly bear or American badger, have been identified in a collision along Highways 1, 22, and 8 (Alberta Transportation 2017). Based on the existing animal-vehicular collision data, the increased mortality risk due to traffic associated with future projects is likely minor for species at risk.

Pre-construction bird nest surveys, and seasonally appropriate surveys undertaken to identify key habitat and habitat features (e.g., breeding wetlands for amphibian species at risk, and roosts for bat species at risk) before construction begins, would reduce the Project's contribution to cumulative effects on bird, amphibian, and bat species at risk.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on mortality risk for species at risk would be low in magnitude and occur at multiple irregular events as future projects go forward. Cumulative effects on mortality risk would be short-term in duration because cumulative effects are limited to the construction phase for

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bird, bat, and amphibian species at risk. However, upgrading Highways 1, 22 and 8 might result in long-term effects on mortality risk for mammal species at risk (e.g., American badger).

Significance of Cumulative Effects on Species at Risk

The cumulative effects on species at risk attributable to the Project as well as all other future projects and activities is considered minor because most of the lands affected are previously disturbed, and do not provide high suitability habitat for species at risk. Future activities combined with the Project's predicted effects on habitat, movement and mortality risk will not threaten the long-term sustainability of species at risk in the RAA.

With mitigation and environmental protection measures, the cumulative effects on species at risk are predicted to be not significant.

Project Contribution to Cumulative Effects on Species at Risk

The contribution of the Project to cumulative effects on species at risk, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because a large portion of the project construction area contains agricultural lands that do not provide high suitability wildlife habitat for species at risk. Although there will be small areas of habitat directly and indirectly affected, the Project's contribution to residual cumulative effects is not expected to measurably affect the abundance or sustainability of species at risk in the RAA because the footprint of the Project's permanent structures is small relative to the remaining habitats available in the RAA.

The contribution of the Project to cumulative increases in mortality risk for species at risk is considered minor because of project-specific mitigation, short-term duration of construction activity, and relatively low human use (i.e., maintenance activities) during dry operations. Although the Project's permanent structures have potential to alter wildlife movement for certain species at risk (e.g., grizzly bear, northern leopard frog), the contribution to cumulative effects is not expected to result in a change in the long-term sustainability of wildlife in the RAA.

Prediction Confidence for Species at Risk

Prediction confidence for residual cumulative effects on species at risk is considered medium. Although the quality and quantity of baseline information used to predict Project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of species at risk within the RAA, as well as specific mitigation measures to be implemented by other future projects.

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1.2.8 Land Use and Management

1.2.8.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on land use and management, but the effects are not significant.

Table 1-11 lists the projects that have potential act cumulatively with residual environmental effects from the Project.

Table 1-11 Interactions with the Potential to Contribute to Cumulative Effects on Land Use and Management, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Land Use
Past and Present Projects and Physical Activities	
Agriculture	✓
Infrastructure	✓
Residential and Communities	✓
Recreation and Tourism	✓
City of Calgary	✓
Project-Related Physical Activities	✓
Future Physical Activities	
Bragg Creek Flood Mitigation	✓
Calgary to Cochrane Trail - Phase 2 and 3	-
The Community of Harmony - Stage 2 and 3	✓
Bingham Crossing Development	-
Upgrades to Highways 1, 8 and 22	-
Southwest Calgary Ring Road	-
Realignment of existing pipelines and utilities	-
NGTL West Path Rocky View Section pipeline	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES:	
✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects.	
- = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

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The Calgary to Cochrane Trail, Bingham Crossing and Southwest Calgary Ring Road are located outside the RAA defined for land use and management. No pathway for cumulative effects is anticipated.

The upgrades to Highways 1, 8 and 22 occur within the RAA defined for land use and management. However cumulative effects on land use and management are not anticipated to result from these activities because the upgrades to Highway 1, 8 and 22 would be expected to occur within the existing right of way and would therefore not result in changes to current land use.

The realignment of existing pipelines will occur within the PDA and the effects of these activities have been accounted for within the residual effects assessment for the Project. Construction of the NGTL West Path Rocky View Section pipeline will involve reclaiming the right-of-way and largely a return to previous use.

1.2.8.2 Changes in Land Use

Cumulative Effect Pathways

Land use in the PDA would be affected by construction of the Project, including permanent removal of private property and agricultural lands and changes to industrial development infrastructure. Current land uses such as industrial activity, livelihood and consumptive and non-consumptive recreation, and access to the LAA would be disrupted by construction, but these land uses would be able to continue at or near current levels during dry operations.

The Community of Harmony will result in changes to land use from agriculture and tame pasture (ranching) land to residential and commercial development. The Bragg Creek Flood Mitigation program will result in a temporary change in access to sites during construction. However once constructed effects to access and current land use would be minimal.

Mitigation for Cumulative Effects

Mitigation measures to address change in land use and management are detailed in Volume 3A, Section 12.4.2.2.

Residual Cumulative Effects

Both the Project and the Community of Harmony will result in a change in land use within the RAA. The Community of Harmony is approximately 700 ha, of which approximately 330 ha is located within the RAA.

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Relative to the availability of agricultural land within the RAA, the change in land use due to the effects of the Project in combination with the Community of Harmony is limited.

With mitigation, the incremental contribution of the Community of Harmony combined with the Project's predicted residual effect on land use would be considered low in magnitude, occur in the RAA, and be long term in duration.

1.2.8.3 Significance of Cumulative Effects

While both the Community of Harmony and the Project will contribute to a change in land use within the RAA, land owners directly affected by the Project will be compensated and current land uses such as industrial activity, livelihood and consumptive and non-consumptive recreation would be able to continue at or near current levels after construction is completed. As such the cumulative effects on land use are not significant.

1.2.8.4 Project Contribution to Cumulative Effects

The Project would result in a temporary restriction of industrial activity, livelihood and consumptive and non-consumptive recreation within the LAA during construction. However, when construction is complete these activities would be able to resume at near pre-construction levels. The Project would result in the reduction of available agricultural land by approximately 500 ha.

1.2.8.5 Prediction Confidence

Prediction confidence is high based on the level of data available on the Project and the Community of Harmony and on the implementation of the mitigation measures.

1.2.9 Traditional Land and Resource Use

1.2.9.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on TLRU during construction and dry operations, but the effects are not significant.

Table 1-12 lists the projects and future physical activities that have the potential to act cumulatively with residual environmental effects from the Project.

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Table 1-12 Interactions with the Potential to Contribute to Cumulative Effects on Traditional Land and Resource Use, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Change in availability of traditional resources for current use	Change in access to traditional resources or areas for current use	Change in current use sites or areas within the area of permanent structures
Past and Present Projects and Physical Activities			
Agriculture	✓	✓	-
Infrastructure	✓	✓	-
Residential and Communities	✓	✓	-
Recreation and Tourism	✓	✓	-
City of Calgary	✓	✓	-
Project-Related Physical Activities	✓	✓	-
Future Physical Activities			
Bragg Creek Flood Mitigation	✓	✓	-
Calgary to Cochrane Trail - Phase 2 and 3	✓	✓	-
The Community of Harmony - Stage 2 and 3	✓	✓	-
Bingham Crossing Development	✓	✓	-
Upgrades to Highways 1, 8 and 22	✓	✓	-
Southwest Calgary Ring Road	✓	✓	-
Realignment of existing pipelines and utilities	✓	✓	-
NGTL West Path Rocky View Section pipeline	-	-	-
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

Adverse residual effects on current use sites and areas from the Project are limited to the PDA and are therefore not anticipated to act cumulatively with the residual effects of future developments in the TLRU RAA. Cumulative effects on trails and travelways, which are intersected by the PDA but also extend into the LAA and RAA, are assessed for cumulative effects.

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1.2.9.2 Change in Availability of Traditional Resources for Current Use

Cumulative Effects Pathways

Potential cumulative effects on the availability of traditional resources for current use due to future projects and activities have similar effects as those identified for the Project. The following describes the potential pathways that could affect the availability of traditional resources. Only those effect pathways where related VCs have identified a potential for residual effects of the Project to interact cumulatively with other projects and physical activities have been included in the discussion. The information presented in this section is in response to potential interactions and pathways identified by Indigenous groups.

Change in Habitat (Vegetation, Wildlife, Fish)

The residual effects of the Project could act cumulatively with the residual effects of future projects to create changes in habitat for traditionally used plant and animal species; such changes could also affect hunting, trapping, fishing, and plant gathering activities. Changes may occur from vegetation removal, sensory disturbance (e.g., noise and artificial light), introduction and establishment of regulated weeds and non-native invasive species, release of deleterious substances into waterbodies, alteration or removal of fish habitat, and water flow disruption.

Change in Movement Patterns (Wildlife, Fish)

The residual effects of the Project could act cumulatively with the residual effects of future projects to change movement patterns in wildlife and fish; such a change could also affect hunting, trapping, and fishing activities. Changes may occur from blockage of fish passage during instream works, or the creation of physical barriers or sensory disturbance that might hinder wildlife movement in the RAA.

Change in Wildlife Biodiversity

Although project effects on species richness and relative abundance are difficult to assess without monitoring, the Project has potential to affect bird and amphibian species richness and relative abundance through the loss and alteration of land cover types.

Change in Mortality (Wildlife)

The residual effects of the Project could act cumulatively with the residual effects of future projects to change mortality risk in wildlife; such a change could affect the availability of traditional resources for current use. Changes may occur from vegetation removal and ground disturbance, which can result in the physical destruction of wildlife habitat features (e.g., nests,

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dens, roosts) and increase mortality risk for wildlife. Changes may also occur from increased road development, which may result in increased animal-vehicle collisions.

Change in Country Foods

The residual effects of the Project on traditionally harvested wildlife, fish and vegetation resources as described above could act cumulatively with the residual effects of future projects and result in corresponding effects on the consumption of country foods by Indigenous groups. The assessment of effects on public health concludes that there are no Project interactions for changes in human health from consumption of country foods during construction and dry operation.

Change in Drinking Water

No pathways for cumulative effects on surface water quality or hydrogeology have been identified as a result of construction and dry operations; therefore, cumulative effects on the traditional use of water, including drinking water, are not anticipated.

Mitigation for Cumulative Effects

Project mitigation and monitoring measures to reduce potential Project effects on availability of traditional resources for current use are presented in Volume 3A, Section 14.3. Although it is unknown the specific mitigation measures that would be implemented by other future projects to reduce potential residual cumulative effects in the RAA, standard mitigation is expected to be implemented. No specific recommendations or mitigation regarding cumulative effects on the availability of traditional resources for current use were identified by Indigenous groups in the TUS reports or through the results of the Indigenous engagement program.

Residual Cumulative Effects

At existing conditions, 33.8% of the RAA contains anthropogenic lands (see Table 1-8). These developments have already contributed substantially to effects on TLRU by altering the distribution and abundance of traditionally harvested resources, reducing the extent of lands available for traditional activities, disturbing or restricting access to TLRU sites and areas, and changing conditions such as air quality, water quality, aesthetics and noise that may influence TLRU. However, current land use by Indigenous groups continues in the RAA on unoccupied Crown lands, such as the riparian zone along the banks of Elbow River, and other lands to which Indigenous groups have been granted permission to access.

Cumulative effects on wildlife and biodiversity, vegetation and wetlands, and fish are limited because most of the lands affected do not contain high suitability habitat, have been previously disturbed or are primarily agricultural, and are relatively small compared to the availability of

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habitat in the RAA. Cumulative effects of the Project are not anticipated to threaten the long-term sustainability of wildlife, fish, or plant species in the RAA.

It is acknowledged that appropriate conditions for current use entail more than availability of traditional resources and that Indigenous groups may choose not to pursue TLRU activities near the Project or other future projects in the RAA for a variety of personal, practical, aesthetic and spiritual reasons. No residual effects on the acoustic environment are anticipated; therefore, there is no pathways for cumulative effects. Given the limited potential for future projects to interact with the residual effects of the Project on terrain and soils, air quality and climate, either temporally or spatially, residual cumulative effects on TLRU are not anticipated.

Therefore, with the combined application of mitigation measures and meaningful engagement of the Project and future projects, the residual cumulative effect on the availability of traditional resources for current use would be low in magnitude and occur at multiple irregular events. The permanent removal of vegetation for all developments will result in the cumulative effects being long term in duration.

1.2.9.3 Change in Access to Traditional Resources or Areas for Current Use

Cumulative Effects Pathways

Potential cumulative effects on access due to future projects and activities have similar effects as those identified for the Project: changes in access can occur through direct loss or alteration of trails and travelways, restrictions on the ability to navigate to and through current use areas, or limitations on the ability to undertake current use activities.

In the Kainai First Nation, Siksika Nation, and Piikani Nation TUS reports, two trails were identified during associated fieldwork for the Project. Few details were provided about these trails, but portions of them occur on private lands and appear to be primarily historical. Kainai First Nation also identified a travelway in the PDA on one property. Because the exact locations and extents of these trails are unknown, there is the potential for these trails to be intersected by future projects in the RAA. Future projects may destroy portions of the trails, or impede access through fencing or other obstacles, either temporarily or permanently.

In the TUS report, Kainai First Nation and Siksika Nation identified Elbow River as an important travel route. It is anticipated that the permanent portage around the in-stream water intake could act cumulatively with adverse residual effects on Elbow River from the Bragg Creek Flood Mitigation, Southwest Calgary Ring Road, the realignment of existing pipelines and utilities, and the upgrades to Highways 1, 8, and 22. The Calgary to Cochrane Trail, the Community of Harmony, and the Bingham Crossing development are not anticipated to interact with Elbow River; therefore no contribution to cumulative effects are anticipated from these future projects.

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Mitigation for Cumulative Effects

Specific Project mitigation and monitoring measures to reduce potential Project effects on access to traditional resources or areas for current use are presented in Volume 3A, Section 14.3. Although the specific mitigation measures are not known that would be implemented by future projects to reduce potential residual cumulative effects in the RAA, standard mitigation is expected to be implemented. No specific recommendations or mitigation regarding cumulative effects on access to traditional resources or areas for current use were identified by Indigenous groups in the TUS reports or through the results of the Indigenous engagement program.

Residual Cumulative Effects

Access to traditional resources and areas for current use is already hindered in the RAA by the amount of private land, commercial developments, transportation and utility networks, tourism and recreation activities, and other infrastructure. The contribution of adverse residual effects on access from the Project and future projects is relatively small in relation to the size of the RAA. Project construction will permanently remove those portions of trails that may be intersected by the PDA; access to and along those trails will be further inhibited should the trails be intersected by future projects.

The adverse residual effects of the Project on Elbow River are limited to the permanent portage around the in-stream water intake. Upgrades to Highway 1, 8 and 22 would be expected to occur within the existing right of way and will therefore not result in further changes to access along Elbow River. The proposed realignment of existing pipelines and utilities is not anticipated to impede access along Elbow River because of the distance of the realignment from the river. The Bragg Creek Flood Mitigation program and Southwest Calgary Ring Road will result in temporary changes in access during construction; however, once constructed, access to Elbow River will return to baseline conditions. The effect on the use of Elbow River is also considered an effect on the use of waterways for recreational purposes by Indigenous groups.

The Project would restrict access on Crown land and to private lands for Indigenous groups through fencing for the purposes of public safety. However, access to some private land is currently permitted by landowners. Because most of the land proposed for use on future projects is privately owned, cumulative changes in access due to fencing and other obstacles are not anticipated. Engagement with Indigenous groups is required to determine which, if any, Indigenous groups have access agreements with private landowners.

Appropriate conditions for current use entail more than access to traditional resources, sites, and locations; Indigenous groups may choose not to pursue TLRU near the Project or future projects for a variety of personal, practical, aesthetic and spiritual reasons.

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With mitigation and meaningful engagement, the residual cumulative effects on access to traditional resources for current use would be low in magnitude, occur at multiple irregular events, but would be long term in duration because of the permanent nature of the components of the Project in combination with the Calgary to Cochrane Trail, the Community of Harmony, and the Bingham Crossing development.

1.2.9.4 Significance of Cumulative Effects

Future projects and activities combined with the Project's predicted cumulative effects on availability of traditional resources for current use and access to traditional resources or areas for current use are not anticipated to critically reduce or eliminate current use from the RAA, except where permanent structures are erected, such as in the Project PDA and the other future project footprints.

With mitigation and environmental protection measures and engagement, the cumulative effects on TLRU are predicted to be not significant.

1.2.9.5 Project Contribution to Cumulative Effects

The contribution of the Project to cumulative effects, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because most of the lands affected consist of previously disturbed lands under private ownership. Indigenous groups will be able to continue TLRU at near current levels in the RAA once construction is completed, except where permanent structures are erected.

1.2.9.6 Prediction Confidence

Based on the extent of the information received from potentially affected Indigenous groups, reliance on assessments of other VCs of relevance to TLRU, and understanding of applicable mitigation measures and future projects, the prediction confidence for residual cumulative effects on TLRU is moderate. Given the qualitative and subjective nature of assessing TLRU, the views of Indigenous communities may differ from the findings of this assessment.

1.2.10 Public Health

1.2.10.1 Project Residual Effects Likely to Act Cumulatively

The Project has the potential to have adverse residual effects on public health. The potential health concerns include the inhalation of exhaust from vehicles and equipment using gasoline or diesel fuel. The changes in air quality would last 36 months during the construction phase with no lasting changes to air quality afterwards. The change in human health from these emissions is a function of a person's proximity to the Project where physical activities are occurring. Specifically, people located within 500 m of the Project would have the highest potential

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change in human health. However, these health concerns were determined to be not significant during the construction phase of the Project. Mitigation such as reducing the number of vehicles and equipment operating close to a residence can effectively reduce the health risk.

Table 1-13 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and activities.

Table 1-13 Interactions with the Potential to Contribute to Cumulative Effects on Public Health, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change to Human Health
Past and Present Projects and Physical Activities	
Agriculture	✓
Infrastructure	✓
Residential and Communities	✓
Recreation and Tourism	✓
City of Calgary	✓
Project-Related Physical Activities	✓
Future Physical Activities	
Bragg Creek Flood Mitigation	-
Calgary to Cochrane Trail - Phase 2 and 3	-
The Community of Harmony - Stage 2 and 3	-
Bingham Crossing Development	-
Upgrades to Highways 1, 8 and 22	-
Southwest Calgary Ring Road	-
Realignment of existing pipelines and utilities	-
NGTL West Path Rocky View Section pipeline	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES:	
✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects.	
- = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

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There are no projects that act cumulatively with the Project, as it relates to public health. There is limited temporal overlap between emissions from the Project during the construction phase, and emissions from other projects. Although these projects contribute emissions to the air, they must be produced in the same time frame in order to have cumulative effects on health. Consequently, there is no pathway for cumulative effects with the Project during the construction phase. There are no activities during the dry operation phase that influences health, and therefore, no cumulative effects during this phase.

The Bragg Creek Flood Mitigation, Calgary to Cochrane Trail and the Southwest Calgary Ring Road are located outside the Project RAA defined for public health; therefore, no pathway for cumulative effects is anticipated.

Residual effects on public health from the Project are anticipated to occur during the construction phase only and not during dry operation. As such, it is not anticipated that Project effects would act cumulatively with upgrades to Highway 1, 8 or 22 because those upgrade activities would occur after the majority of the Project has been constructed. Project construction activities after 2020 will be focused on the berm structure and will have limited potential to overlap with upgrades to the highways.

The realignment of existing pipelines will occur within the PDA and the effects have been accounted for within the residual effects assessment for the Project. Emissions from the NGTL West Path Rocky View Section pipeline will be minor and intermittent, limited to some equipment as construction moves along the right-of-way.

The Community of Harmony and Bingham Crossing developments are located within the Project RAA defined for public health. Construction of both the Community of Harmony and Bingham Crossing would be expected to have similar emissions during construction as the Project (i.e., diesel fueled construction equipment and fugitive dust emissions). Due to the anticipated construction activities and schedule, distance between the Community of Harmony and Bingham Crossing and the PDA, and prevailing wind conditions, it is considered there are limited opportunities for emissions from the three projects to overlap. Emissions from the Community of Harmony and Bingham Crossing would not be expected to materially change the predicted Project residual effects conclusions. Given this, cumulative effects to public health because of air quality emissions during construction are not predicted.

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1.2.11 Infrastructure and Services

1.2.11.1 Project Residual Effects Likely to Act Cumulatively

The Project has the potential to have adverse residual effects on infrastructure and services, but the effects are not significant, during Project construction.

Table 1-14 lists the projects and future physical activities that have the potential to act cumulatively with residual environmental effects from the Project.

Table 1-14 Interactions with the Potential to Contribute to Cumulative Effects on Infrastructure and Services, Construction and Dry Operations

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Transportation Infrastructure and Services
Past and Present Projects and Physical Activities	
Agriculture	✓
Infrastructure	✓
Residential and Communities	✓
Recreation and Tourism	✓
City of Calgary	✓
Project-Related Physical Activities	✓
Future Physical Activities	
Bragg Creek Flood Mitigation	✓
Calgary to Cochrane Trail - Phase 2 and 3	✓
The Community of Harmony - Stage 2 and 3	✓
Bingham Crossing Development	✓
Upgrades to Highways 1, 8 and 22	✓
Southwest Calgary Ring Road	✓
Realignment of existing pipelines and utilities	✓
NGTL West Path Rocky View Section pipeline	✓
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

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1.2.11.2 Changes in Infrastructure and Services

Cumulative Effect Pathways

Projects that may act cumulatively with infrastructure and services are residential and commercial developments in the RAA (Community of Harmony and Bingham Crossing), upgrades to Highway 1, 8 and 22, the Calgary to Cochrane Trail, Bragg Creek Flood Mitigation, NGTL West Path Rocky View Section pipeline and the realignment of existing pipelines and utilities. These projects may cause temporary disruption to transportation, increase the population of the area, either temporarily or permanently, placing additional demands on transportation in the RAA.

Mitigation for Cumulative Effects

Mitigation measures to reduce the Project's effects on transportation are described in Volume 3A, Section 16.

In order to manage cumulative effects on provincial and municipal services and infrastructure, proper planning by relevant agencies, and implementation of appropriate management strategies, particularly with respect to population growth, will be required.

Residual Cumulative Effects

Construction of the Project requires raising the grade-line of Highway 22 west of the existing lanes and building a new bridge over the diversion channel on the existing alignment. This will temporarily detour traffic along other routes and potentially cause traffic disruptions.

Current and future residential development in the RAA will increase the permanent population of RAA communities, which will ultimately increase demands on the local road system. The presence of construction vehicles and equipment associated with other projects, and the transportation of employees of these projects, will periodically increase local traffic and may cause brief traffic disruptions. However, with project mitigation and the existing spare capacity of the local road network, increased traffic will likely be accommodated.

Where road improvements are made, all projects and users generally could benefit. The occurrence of current and future road development in the RAA will most likely have positive cumulative effects on transportation, because road improvements would increase the capacity of local roads.

It is anticipated that these initiatives will be successful in maintaining or improving current conditions in the RAA such that the cumulative residual adverse effects on transportation during construction are predicted to be low in magnitude, short-term, and continuous.

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1.2.11.3 Significance of Cumulative Effects

Effects on infrastructure and services are primarily a result of increases in the population of an area, which can lead to decreases in the available capacity of existing transportation infrastructure. Because local roads can handle additional traffic and there are planned improvements to highways in the RAA, there is not likely to be a decrease in the quality of infrastructure and services provided, on a persistent and ongoing basis. Therefore, the cumulative environmental effects on a change in capacity of infrastructure and services are not significant.

1.2.11.4 Project Contribution to Cumulative Effects

The Project is anticipated to have a minor incremental contribution to cumulative effects in the region for infrastructure and services.

1.2.11.5 Prediction Confidence

Prediction confidence is moderate to high. Prediction confidence is high for the Project contribution to cumulative effects due to known effectiveness of the standard management tools and mitigation measures that would be in place, readily understood effects of the planned construction activities and the capacity of the existing local transportation network. Prediction confidence is considered moderate for other future activities based on the information available for those activities.

1.3 CUMULATIVE EFFECTS ASSESSMENT – FLOOD AND POST-FLOOD

1.3.1 Air Quality and Climate

1.3.1.1 Project Residual Effects Likely to Act Cumulatively

The post-flood phase of the Project could result in fugitive dust emissions from wind erosion from the reservoir surface of the deposited sediment during high wind speed conditions. In addition, there is a potential for odours related primarily to decaying vegetation in reservoir (after draining) and a potential for decrease of the carbon sequestration capacity during the post-flood period due to reduced vegetation activity. Potential odours and change in carbon sequestration capacity do not have adverse effects on ambient air quality and climate and are, therefore, not included in the cumulative assessment. The residual effects are found to be not significant.

Because the reservoir will contain water during reservoir filling and draining, no fugitive dust emissions are expected during flood operations. Adverse residual effects during flood operations are not anticipated.

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Table 1-15 lists the residual environmental effects due to the flood and post-flood operations that have the potential to act cumulatively with other projects and future physical activities.

Table 1-15 Interactions with the Potential to Contribute to Cumulative Effects on Air Quality and Climate, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Fugitive Dust
Past and Present Projects and Physical Activities (Dry Operations)	✓
Future Physical Activities	
The Community of Harmony - Stage 2 and 3	✓
Upgrades to Highways 1, 8 and 22	✓
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-

With respect to cumulative effects during post-flood operations, fugitive dust emissions from wind erosion of the deposited sediment are expected to be limited to a maximum of a five-month summer period (June to October) after the occurrence of 1:100 to 1:200 year floods. The highest probability of a flood occurring is during May to September. Windblown emissions are not expected to occur during winter periods when the ground is frozen or covered with snow. In the long term (more than one year), fugitive dust emissions will be effectively mitigated by revegetation of the sediment surface after a flood. The other projects and future physical activities identified in Table 1-15 have construction activities that are also of limited duration.

The Project is scheduled to accommodate a 1:100 year flood in the spring of 2021 and be fully constructed to accommodate a design flood in the spring of 2022. Fugitive dust emissions during the post-flood phase are assumed to occur at the earliest in 2021 for the 1:100 year flood and in 2022 for the design flood. Given this timing, there will be limited overlap of Project fugitive dust emissions and emissions with other projects. Other physical activities that occur in the air quality LAA or RAA, and could take place during post-flood operations, are the Community of Harmony development and upgrades to Highways 1, 8 and 22.

1.3.1.2 Changes in Air Quality

Cumulative Effect Pathways

During post-flood operations, fugitive dust emissions could result from wind erosion of the surface of the deposited sediment during high wind conditions. The hydrological modelling of sediment deposition (Volume 3B, Section 6.4.3 and Volume 4 Appendix J, Hydrology TDR, Section 3) predicts that the 1:100 year flood and design flood could result in measurable sediment deposition. For a 1:10 year flood, the hydrological model predicts negligible sediment

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deposition. Therefore, fugitive dust emissions are estimated for the 1:100 year and the 1:200 year floods. Emissions are estimated for particulate matter with various particle sizes for which ambient air quality criteria are established. The substances assessed are particulate matter with particle aerodynamic diameter less or equal to $2.5 \mu\text{m}$ ($\text{PM}_{2.5}$) and total suspended particulates (TSP) with particle aerodynamic diameter of less or equal to approximately $30 \mu\text{m}$. Fugitive dust emissions occur only under high wind conditions and the magnitude of emission rates vary with wind speed.

Ambient air quality in the LAA will be influenced by emissions from the Project and from other future sources. The air quality assessment in Volume 3B, Section 3.3 explicitly considers contributions from the Project and other main sources in the LAA (i.e., TransCanada Highway (Highway 1), Highway 22, Highway 8, and the Springbank Road traffic; and a nearby compressor station). The air quality assessment also implicitly includes other sources (e.g., lower volume secondary roads and residential/commercial heating) through the inclusion of a background level. The background level is estimated from representative ambient air quality measurements.

Because the fugitive dust emissions are ground based, the greatest air quality changes due to these emissions occur inside and near the PDA, decreasing to background levels with increasing distance from the PDA. The highest ground-level concentrations of $\text{PM}_{2.5}$ and TSP are predicted along and near the east PDA boundary.

The Community of Harmony is 5 km northeast of the PDA. Emissions will result from construction activities that will be spread over a 15-year phased development period. Fugitive dust emissions are expected to occur primarily during the initial clearing, grading, and road construction phase.

Highway 22 intersects the PDA. The Highway 1 and 22 interchange is located approximately 500 m north of the PDA. The Highway 8 and 22 interchange is located approximately 2 km south of the south PDA boundary. Emissions will result from road construction activities. Products of combustion will result from construction equipment and vehicle exhaust, and fugitive dust emissions will result from surface disturbance activities.

Mitigation for Cumulative Effects

Mitigation measures will be implemented to manage and reduce Project fugitive dust emissions during the post-flood operations. A primary mitigation for wind erosion in the reservoir would be the re-establishment of vegetation cover (e.g., native grasses) after reservoir draining. In short term, the natural revegetation could be ineffective due to various factors and, therefore, a tackifier would be applied where required. Tackifiers are a sprayable erosion control product that bonds with the soil surface and creates a porous and absorbent erosion resistant blanket that can last for up to 12 months. Mitigation measures for air quality are identified in Volume 3B, Section 3.2.4. No additional mitigation measures specific to cumulative effects are proposed.

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Because the Community of Harmony will be developed and occupied in phases over an extended 15-year period, it is expected that the developer will manage construction emissions to reduce air quality changes in adjacent developed (i.e., occupied) phases. The Harmony earthworks contractor has implemented an idling policy on large earth moving equipment to reduce idling tailpipe emissions. It is expected that road construction activities associated with upgrades to Highways 1, 8 and 22 will follow best management practices (BMPs) to reduce combustion and fugitive dust emissions during construction.

Residual Cumulative Effects

Anticipated residual effects are based on air quality model predictions that include baseline and project emissions. Ambient background concentrations are added to the model predictions to account for smaller sources inside the LAA and other sources outside the LAA that are not explicitly included in the model simulations. The model predictions indicate a potential for high TSP concentrations along and near the eastern boundary of the PDA. The maximum predicted PM_{2.5} concentrations are less than the applicable ambient air quality criteria. The highest PM_{2.5} concentrations are predicted also along and near the eastern boundary of the PDA.

Relative to the Community of Harmony, the Stage 2 and 3 development, associated construction emissions are expected to commence in 2019 and continue beyond 2020. Future construction emissions are implicitly accounted for by the ambient background concentrations included for the Project. An examination of Springbank Airport wind measurements (Volume 3A, Section 3.2.2.2, Figure 3-3) indicates the least frequent wind directions are from the northeast and southwest quadrants. This suggests limited potential for emissions from the Project to overlap with those from the Community of Harmony. Furthermore, fugitive dust emissions from the Project would occur only during high winds and in short term since it is expected that in long term (longer than a year) revegetation would effectively eliminate the potential for windblown emissions.

Emissions associated with upgrades to Highways 1, 8 and 22 are expected to occur after 2020. Future construction emissions are implicitly accounted for by the ambient background concentrations included for the Project. The highest predicted PM_{2.5} and TSP concentrations for the Project occur along and near the eastern boundary of the PDA. Highway 22, the Highway 1 and 22 interchange, and the Highway 8 and 22 interchange are located 3 to 5 km from the eastern boundary of the PDA. Because the construction emissions associated with future road developments are ground based, the air quality changes due to these emissions are expected to decrease to background levels within 3 km to 5 km. Fugitive dust emissions from the Project would occur only during high wind conditions, which reduces the probability of construction emissions from road developments to overlap with project emissions.

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1.3.1.3 Significance of Cumulative Effects

With the implementation of mitigation measures, the residual effects of the Project on air quality are not significant (Volume 3B, Section 3.3). Given the limited potential for future projects to interact with the Project, either temporally or spatially, the residual cumulative environmental effect is also predicted to be not significant.

1.3.1.4 Project Contribution to Cumulative Effects

Adverse air quality effects due to the Project occur along and near the eastern boundary of the PDA. The contribution of the other identified future physical activities at this boundary is limited. The Project is anticipated to contribute more to the cumulative effect on air quality than the other identified future physical activities; however, it will be limited in duration because exposed sediments are expected to be revegetated within a one-year period, and limited in frequency given the rarity of floods.

1.3.1.5 Prediction Confidence

The mechanisms causing these potential changes are well understood and there are industry proven BMPs to mitigate potential effects. Emissions from other future sources have not been modelled because detailed information on those activities is unavailable. Therefore, overall confidence in predictions is moderate.

1.3.2 Hydrogeology

1.3.2.1 Project Residual Effects Likely to Act Cumulatively

Groundwater levels in the RAA are anticipated to respond to floods in Elbow River due to their hydraulic connection to surface water and interactions between the hydrologic and hydrogeologic systems. These responses to floods are anticipated to occur with or without the Project. Changes to groundwater quantity will be both positive (in areas where the net change in ground water levels is positive) and adverse (in areas where the net change in groundwater level is negative). The extent of changes will be limited to the LAA and duration of the effects are considered to be short term in the off-stream reservoir because groundwater levels should recover to pre-flood levels within one year following the end of the flood. Duration of the effects near the diversion channel are long term because seepage into the channel will continue indefinitely. Groundwater seepage into the dry diversion channel would occur only in some areas where the local groundwater table is near ground surface and where the diversion channel has been cut to an elevation below the water table.

Potential changes in groundwater quality could occur during floods due to alterations in groundwater flow patterns in areas near the Elbow River valley or in areas near the diversion channel and off-stream reservoir. Downward or lateral infiltration of flood affected surface water

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into the subsurface groundwater system could result in changes in groundwater quality. Changes may be positive or adverse, depending upon the chemical species under consideration. The extent of changes will be limited to the LAA and duration of the effects are short term because modeling indicates groundwater levels will recover to pre-flood levels within one year following the end of the flood.

Table 1-16 lists the residual environmental effects due to the flood and post-flood operation that have the potential to act cumulatively with other projects and future physical activities.

Table 1-16 Interactions with the Potential to Contribute to Cumulative Effects on Hydrogeology, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects	
	Change in Groundwater Quantity	Change in Groundwater Quality
Past and Present Projects and Physical Activities (Dry Operations)	-	-
Future Physical Activities		
The Community of Harmony - Stage 2 and 3	-	-
Upgrades to Highways 1, 8 and 22	-	-
Rocky View County Springbank Master Drainage Plan	-	-
City of Calgary	-	-

Completion of construction of the Community of Harmony, which also has limited overlap with the northeast perimeter of the RAA, has not been determined; therefore, a conservative assumption is that construction may still be occurring in 2022 during flood and post-flood operations. Effects on groundwater quantity and quality due to the Project during flood and post-flood operations are anticipated to be limited to the LAA. Given the distance between the development and the Project, and the duration of Project effects (modeling suggests groundwater levels would recover to pre-flood levels within one year after a flood), the potential for cumulative effects on groundwater quantity and quality are negligible.

Upgrades to Highways 1, 8 and 22 could potentially be occurring during flood and post-flood operations. It is assumed all work on highways would cease in the event of a flood. Should dewatering for highway upgrade activities be occurring at the same time as a flood, and occur within the LAA, then there is a potential for a cumulative effect pathway. However, given the short term and limited magnitude of any dewatering for highway upgrades, the potential for cumulative effects on groundwater quantity and quality are negligible.



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1.3.3 Hydrology

1.3.3.1 Project Residual Effects Likely to Act Cumulatively

The purpose of the Project is to actively modify the hydrology of Elbow River in order to reduce flood damage downstream of the Project. As described in Volume 3B, Section 6.4, the Project is anticipated to have adverse residual effects on hydrology for the following unique effects.

Evaporation

Alteration of both peak flow rate and flow volume in the Elbow River is the intended purpose of the Project, with some increase in evaporation of diverted water while it is retained in the reservoir. At an RAA scale, the percentage lost to evaporation is less than 0.5% of the annual flow volume. Given that the probability of diversion is 10% or less in any given year, changes to the hydrological regime due to diversion would likely have a negligible effect on long-term median flow values.

Suspended Sediment Concentrations and Local Suspended Sediment Yields

The modelled effect on suspended sediment concentrations and yields in Elbow River suggest that during diversion there would be a high magnitude effect. Higher magnitude floods would have yield reductions greater than 30% compared to existing conditions in Elbow River. Release of water from the reservoir would temporarily increase localized suspended sediment concentrations and yields in Elbow River.

During diversion, there would be a high magnitude effect on the morphology of Elbow River. The Project would reduce aggradation and degradation on Elbow River during a large flood. During release, there would be a high magnitude effect on the morphology of the unnamed creek at the low-level outlet. Although high magnitude effects are predicted in Elbow River, channel planform and bedload movement is predicted to be maintained and that only the magnitude of aggradation and degradation, during diversion, would be affected.

Table 1-17 lists the residual environmental effects due to the flood and post-flood operations that have the potential to act cumulatively with other projects and future physical activities.

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Table 1-17 Interactions with the Potential to Contribute to Cumulative Effects on Hydrology, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Change in Hydrological Regime	Change in Suspended Sediment Transport	Change in Channel Morphology
Past and Present Projects and Physical Activities (Dry Operations)	-	-	-
Future Physical Activities			
The Community of Harmony - Stage 2 and 3	-	-	-
Upgrades to Highways 1, 8 and 22	-	-	-
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

While located within the RAA, the Community of Harmony and upgrades to Highways 1,8 and 22 would not be expected to affect the hydrology of Elbow River and, therefore, no pathway exists for cumulative effects with the Project.

1.3.4 Surface Water Quality

1.3.4.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on surface water quality during flood and post-flood operations. The effect of the Project on water quality is not significant because the change in water quality is not anticipated to cause acute or chronic toxicity or change the trophic status of Elbow River or Glenmore Reservoir. Even though the total load of sediment in Elbow River is reduced by the Project, flood operations is not predicted to substantially affect Elbow River suspended sediment concentrations during diversion. The Project does increase suspended sediment concentrations for a short duration (days) at the end of release of water back into Elbow River.

Table 1-18 lists the residual environmental effects due to the project flood and post-flood operations that have the potential to act cumulatively with other projects and future physical activities.

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Table 1-18 Interactions with the Potential to Contribute to Cumulative Effects on Surface Water Quality, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Water Quality
Past and Present Projects and Physical Activities (Dry Operations)	-
Future Physical Activities	
The Community of Harmony - Stage 2 and 3	-
Upgrades to Highways 1, 8 and 22	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-

Detailed construction schedules are not available for the Community of Harmony and the upgrades to Highways 1, 8 and 22. Therefore, it is conservatively assumed that construction may still be occurring in 2022, at the same time as assumed flood and post-flood operations. The Community of Harmony is located a 5 km to 6 km from the PDA/LAA within which Project residual effects during a flood are predicted. Given the distance between the development and the PDA/LAA and the fact that standard industry mitigation and best management practices would be implemented at the development site, the potential for cumulative effects on surface water quality during flood and post-flood operations is negligible.

Potential upgrades to Highways 1, 8 and 22 will implement standard industry mitigation and best management; residual effects on surface water quality are not anticipated. In the absence of residual effects from these activities on surface water quality, there is no pathway for cumulative effects with the Project during flood and post-flood operations.

1.3.5 Aquatic Ecology

1.3.5.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on aquatic ecology (due to permanent alteration of fish habitat and the death of fish during flood and post-flood operations). High magnitude effects are predicted in bedload changes (aggradation and degradation) in Elbow River and channel shape and, therefore, fish habitat. These changes to fish habitat should however not affect the abundance or distribution of bull trout or cutthroat trout in Elbow River, nor affect fish species that support CRA fisheries and SAR. The permanent alteration of fish habitat from the Project is not significant.

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The Project may result in fish mortality that can threaten the long-term persistence and/or viability of aquatic species and fish that support a CRA fishery in the RAA because during post-flood operations, stranding in the off-stream reservoir is expected to cause mortality of fish. During the diversion of flood water from Elbow River to the off-stream reservoir, fish, at any of their lifestages present, would encounter the diversion structure. This could result in the entrainment of up to 80% of the fish (based on that percentage of volume flow diversion during the design flood) that are upstream and near the diversion structure or being swept downstream during flooding. Increased mortality from water quality is not considered to cause significant effects because the change in water quality is not anticipated to cause acute or chronic toxicity or change the trophic status of Elbow River or Glenmore Reservoir.

Table 1-19 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and future physical activities.

Table 1-19 Interactions with the Potential to Contribute to Cumulative Effects on Aquatic Ecology, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Permanent Alteration of Fish Habitat	Destruction of Habitat	Death of Fish
Past and Present Projects and Physical Activities (Dry Operations)	-	-	-
Future Physical Activities			
The Community of Harmony - Stage 2 and 3	-	-	-
Upgrades to Highways 1, 8 and 22	-	-	-
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

The Community of Harmony development is located outside the RAA (the Elbow River watershed) defined for aquatic ecology. Therefore, no pathway for cumulative effects are anticipated.

Potential upgrades to Highways 1,8, and 22 would occur within the RAA. However, these projects will implement standard industry mitigation and best management. Therefore, residual effects on aquatic ecology because of permanent alteration of fish habitat are not anticipated.

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1.3.6 Terrain and Soils

1.3.6.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on terrain stability, soil quality and soil quantity during flood and post-flood operations.

Table 1-20 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and future physical activities.

Table 1-20 Interactions with the Potential to Contribute to Cumulative Effects on Terrain and Soils, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects	
	Change in Soil Quality and Quantity	Change in Terrain Stability
Past and Present Projects and Physical Activities (Dry Operations)	-	-
Future Physical Activities		
The Community of Harmony - Stage 2 and 3	-	-
Upgrades to Highways 1, 8 and 22	-	-
Rocky View County Springbank Master Drainage Plan	-	-
City of Calgary	-	-

Detailed construction schedules are not available for the Community of Harmony and the upgrades to Highway 1, 8 and 22; therefore, it is conservatively assumed that construction may still be occurring in 2022, at the same time as flood and post-flood operations.

Reservoir draining has the potential to affect terrain stability along channel banks within the off-stream reservoir. During release of reservoir water, the low-level outlet channel would be subject to a major shift in stream flow regime that could destabilize stream banks. Similar effects on terrain would not be expected from the residential development of the Community of Harmony or highway upgrades. Therefore, there is no pathway for cumulative effects with the Project.

The flooding, draining and post-flood conditions of the off-stream reservoir can affect the agricultural land capability (LCC) through changes to the soil drainage regime, soil nutrient properties (soil anoxia), physical and chemical properties, soil depth, soil salinity, water erosion and wind erosion risk. The cumulative effects to LCC (i.e., loss of agricultural land) from the Project and the Community of Harmony and highway upgrades is addressed under dry operations, Section 1.2.5. No additional effects during flood and post-flood operations on LCC are expected because the land use during operations will be non-agricultural. In the absence of effects to LCC during flood and post-flood operations, there is no pathway for cumulative effects.

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1.3.7 Vegetation and Wetlands

1.3.7.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on vegetation and wetlands during flood and post-flood operations.

Table 1-21 lists the residual environmental effects due to the Project that have the potential to act cumulatively with other projects and activities.

Table 1-21 Interactions with the Potential to Contribute to Cumulative Effects on Vegetation and Wetlands, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Change in Plant Community Diversity	Change in Species Diversity	Change in Wetland Function
Past and Present Projects and Physical Activities (Dry Operations)	✓	-	-
Future Physical Activities			
The Community of Harmony - Stage 2 and 3	✓	-	-
Upgrades to Highways 1, 8 and 22	✓	-	✓
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

The cumulative effects of future physical activities and the Project on vegetation and wetlands have been assessed in Section 1.2.6 for construction and dry operations. Additional changes from the other activities during a flood are not anticipated and their contribution has already been accounted for at baseline. At flood and post-flood operations, baseline conditions include permanent structures of the Project (i.e., dry operations) and all future project developments as new permanent loss of habitat in the RAA, and floods as temporary inundation (i.e., inaccessible) and/or alteration of habitat. As such, change from baseline in the RAA will only be from floods.

During flood operations, there would be an incremental change to plant community diversity in the reservoir area of less than 1% for native upland and wetland cover in the RAA (Table 1-22), as well as for post-flood operations.



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Table 1-22 Change in Land Cover Types for Baseline and Floods in the RAA

Vegetation Cover Type ^a	Baseline		Design Flood				1:100 Flood				1:10 Flood			
	Amount of Cover Types in the RAA		Amount of Cover Types in the RAA		Change from Baseline to Design Flood		Amount of Cover Types in the RAA		Change from Baseline to Design Flood		Amount of Cover Types in the RAA		Change from Baseline to Design Flood	
	Area (ha)	% RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA	Area (ha)	% RAA	Area Change (ha)	% Change in RAA
Broadleaf Forest	10,181.7	9.9	10,181.7	9.9	0.0	0.0	10,181.7	9.9	0.0	0.0	10,181.7	9.9	0.0	0.0
Coniferous Forest	7,653.6	7.4	7,652.8	7.4	-0.8	0.0	7,653.6	7.4	0.0	0.0	7,653.6	7.4	0.0	0.0
Mixed Forest	6,347.7	6.2	6,347.7	6.2	0.0	0.0	6,347.7	6.2	0.0	0.0	6,347.7	6.2	0.0	0.0
Shrubland	2,682.0	2.6	2,682.0	2.6	0.0	0.0	2,682.0	2.6	0.0	0.0	2,682.0	2.6	0.0	0.0
Grassland	27,359.6	26.6	26,895.2	26.2	-464.4	-1.7	27,079.9	26.3	-279.6	-1.0	27,343.5	26.6	-16.0	-0.1
Exposed Land	69.7	0.1	69.7	0.1	0.0	0.0	69.7	0.1	0.0	0.0	69.7	0.1	0.0	0.0
<i>Upland Subtotal</i>	<i>54,294.3</i>	<i>52.8</i>	<i>53,829.1</i>	<i>52.4</i>	<i>-465.2</i>	<i>-0.9</i>	<i>54,014.7</i>	<i>52.5</i>	<i>-279.6</i>	<i>-0.5</i>	<i>54,278.3</i>	<i>52.8</i>	<i>-16.0</i>	<i>0.0</i>
Riparian	1,042.4	1.0	1,032.6	1.0	-9.8	-0.9	1,042.4	1.0	0.0	0.0	1,042.4	1.0	0.0	0.0
Wetland	861.8	0.8	857.2	0.8	-4.7	-0.5	857.2	0.8	-4.7	-0.5	861.8	0.8	0.0	0.0
<i>Wetland Subtotal</i>	<i>1,904.3</i>	<i>1.9</i>	<i>1,889.8</i>	<i>1.8</i>	<i>-14.5</i>	<i>-0.8</i>	<i>1,899.6</i>	<i>1.8</i>	<i>-4.7</i>	<i>-0.2</i>	<i>1,904.3</i>	<i>1.9</i>	<i>0.0</i>	<i>0.0</i>
Water	1,662.6	1.6	1,659.2	1.6	-3.4	-0.2	1,662.2	1.6	-0.4	0.0	1,662.6	1.6	0.0	0.0
<i>Water Subtotal</i>	<i>1,662.6</i>	<i>1.6</i>	<i>1,659.2</i>	<i>1.6</i>	<i>-3.4</i>	<i>-0.2</i>	<i>1,662.2</i>	<i>1.6</i>	<i>-0.4</i>	<i>0.0</i>	<i>1,662.6</i>	<i>1.6</i>	<i>0.0</i>	<i>0.0</i>
Agriculture	21,070.7	20.5	21,025.1	20.4	-45.6	-0.2	21,042.1	20.5	-28.6	-0.1	21,069.3	20.5	-1.4	0.0
Disturbed Land ^b	14,551.4	14.2	15,264.7	14.8	713.3	4.9	14,997.5	14.6	446.1	3.1	14,571.0	14.2	19.6	0.1
Tame Pasture or Hay	9,333.5	9.1	9,148.8	8.9	-184.7	-2.0	9,200.7	8.9	-132.8	-1.4	9,331.3	9.1	-2.2	0.0
<i>Anthropogenic Subtotal</i>	<i>44,955.5</i>	<i>43.7</i>	<i>45,438.6</i>	<i>44.2</i>	<i>483.1</i>	<i>1.1</i>	<i>45,240.2</i>	<i>44.0</i>	<i>284.7</i>	<i>0.6</i>	<i>44,971.6</i>	<i>43.7</i>	<i>16.0</i>	<i>0.0</i>
Grand Total	102,816.7	100.0	102,816.7	100.0	0.0	0.0	102,816.7	100.0	0.0	0.0	102,816.7	100.0	0.0	0.0

NOTES:
^a Vegetation cover type was classified using ABMI's LCC spatial data (ABMI 2010). The cover types for the RAA differ from the LAA, where land units (ecosites) were used for spatial data.
^b Disturbed land at baseline includes existing disturbance, dry operations project structures, and future developments. Disturbed land in the floods include existing disturbance, dry operations Project structures, future developments, and the diverted flood water in the off-stream reservoir.

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1.3.7.2 Significance of Cumulative Effects on Vegetation and Wetlands

The cumulative effect on vegetation and wetlands attributable to the Project in combination with future projects is limited relative to the amount of vegetation and wetlands occurring throughout the RAA. The cumulative effect of the Project combined with future projects is not predicted to:

- threaten the long-term persistence or viability of a plant species or community in the RAA
- result in unreplaced loss or disturbances of wetlands that has not been giving prior approval by Alberta Environment and Parks
- threaten the long-term availability of traditionally use plants within the regional assessment area

Therefore, with mitigation and environmental protection measures, the cumulative effects on vegetation and wetlands are predicted to be not significant.

1.3.7.3 Project Contribution to Cumulative Effects

The contribution of the Project to cumulative effects, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because the amount of vegetation and wetlands affected due to floods is small compared to the availability of similar vegetation and wetlands remaining in the RAA.

1.3.7.4 Prediction Confidence

Prediction confidence is moderate, because there is uncertainty regarding the abundance and distribution of plant and ecological communities of management concern in the LAA (beyond the PDA) and within the footprint of identified future projects.

1.3.8 Wildlife and Biodiversity

This section provides an assessment of potential cumulative effects on wildlife and biodiversity, organized in the following four parts:

- identification of project residual effects likely to act cumulatively
- an assessment of potential cumulative effects on wildlife in general, and biodiversity (sections 1.3.8.1)
- an assessment of potential cumulative effects on migratory birds (section 1.3.8.2)
- an assessment of potential cumulative effects on species at risk (section 1.3.8.3)

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Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse, short term effects on wildlife during flood and post-flood operations. These include temporary reduction in habitat availability (i.e., inaccessible habitat), some alteration in habitat from sedimentation, temporary disruption to movement, and a temporary increase in mortality risk for certain species. The effects would be primarily limited to the LAA and would be reversible.

Table 1-23 lists the other projects and future physical activities that have the potential to act cumulatively with residual environmental effects from the Project during flood and post-flood operations. Baseline condition for the flood and post-flood operations is the dry operations phase of the Project with other future project activities complete (or at maximum build out).

Table 1-23 Interactions with the Potential to Contribute to Cumulative Effects on Wildlife, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects				
	Change in Habitat	Change in Movement	Change in Mortality Risk	Change in Biodiversity	Change in Wildlife Health
Past and Present Projects and Physical Activities (Dry Operations)	✓	✓	✓	-	-
Future Physical Activities					
The Community of Harmony - Stage 2 and 3	✓	✓	✓	-	-
Upgrades to Highways 1, 8 and 22	✓	✓	✓	-	-
Rocky View County Springbank Master Drainage Plan	-	-	-	-	-
City of Calgary	-	-	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.					

Project residual effects on biodiversity and wildlife health at flood and post-flood operations are negligible and, therefore, are not discussed further in this cumulative effects assessment.

The cumulative change in habitat from future project activities during Project construction and dry operations has been assessed in Section 1.2.7. At flood and post-flood operations, the cumulative change in habitat considers baseline conditions as permanent structures of the

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Project (i.e., dry operations) and all future project developments as new permanent loss of habitat in the RAA, and floods as temporary inundation (i.e., inaccessible) and/or alteration of habitat. As such, change from baseline in the RAA will only be from floods.

Because construction on other projects may still occur at the time of a flood, the Community of Harmony and the upgrades to Highway 1, 8 and 22 also have potential to act cumulatively with changes in movement and mortality risk to wildlife during flood and post-flood operations.

1.3.8.1 Cumulative Effects on Wildlife and Biodiversity

Change in Habitat

Cumulative Effects Pathway

Flood operations have the potential to directly affect wildlife habitat in the RAA through the temporary diversion of flood waters into the off-stream reservoir. The depth and extent of flood water would temporarily render habitat inaccessible in the reservoir for most wildlife species. This change in habitat would be temporary and is expected to last up to 45 days and extend approximately up to 39 more days for the reservoir to drain and post-flood maintenance activities to occur. During post-flood operations, potential direct effects on wildlife habitat would include sediment deposition that would result in covering vegetation and reducing habitat suitability for wildlife in the drained reservoir as well as revegetation of the diversion channel, off-stream dam, and floodplain berm, which might be damaged or eroded during a flood. Sensory disturbance caused by maintenance equipment might contribute to temporary indirect effects on wildlife (i.e., habitat avoidance or displacement).

Future projects such the Community of Harmony will have already reduced wildlife habitat availability in the RAA. Flood operations will act cumulatively to temporarily reduce habitat availability in the RAA. Post-flood operations will result in most of the habitat returning to dry operations conditions, but with some alterations due to left-over sediment in the reservoir.

Mitigation for Cumulative Effects

Mitigation recommended for change in habitat will reduce residual effects of the Project. Highway upgrades and construction at the Community of Harmony would be expected to implement industry-standard mitigation measures to reduce potential effects on wildlife habitat in the RAA.

Residual Cumulative Effects

The amount of vegetation cover types in the RAA at baseline is shown in Table 1-22. About 52.8% of the RAA is native upland cover, 1.9% is wetland cover, and 43.7% is anthropogenic lands (which 9.1% is tame pasture or hay). During a design flood, the Project would contribute to a

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cumulative change in habitat; however, the change in habitat abundance (816 ha) would be temporary and represents less than 1% of the upland and wetland cover types available in the RAA. The most affected cover type in the RAA during a design flood would be tame pasture and hay at 2%, followed by grassland at 1.7%. Key indicator species most affected by a design flood include Sprague's pipit and elk and, to a certain extent, grizzly bear (i.e., spring forage for forbs). However, suitable grassland and tame pasture habitat exists outside the off-stream reservoir. The 1:00 and 1:10 year floods would have smaller cumulative residual effects on wildlife habitat.

During post-flood operations, the Project would cumulatively contribute a small change in native upland and wetland cover due to sediment deposition. During a design flood, sediment modeling predicts that 192.6 ha of the reservoir would be covered by sediment that is less than 3 cm deep, and 37.4 ha would be covered by sediment between 3 cm and 10 cm (see Volume 3B, Section 10.2.2). The quality of vegetation and wetlands post-flood would differ from baseline conditions. However, changes to overall wildlife habitat abundance and suitability would be minor under these conditions. Sediment deposition of more than 10 cm is predicted to affect 145.4 ha in the reservoir and sediment deposition of greater than 1 m deep would affect 40.8 ha in the reservoir. Overall, higher sediment depths would have relatively greater effects on the suitability of wildlife habitat; however, higher sediment depths (i.e., greater than 10 cm), would result in a small change in habitat (186.2 ha), representing 0.18% of the RAA.

In addition to the sediment in the reservoir, sensory disturbance from maintenance activities could affect habitat suitability in the reservoir; however, mitigation will reduce cumulative residual effects of the Project to near baseline levels with future projects in place.

The residual cumulative effect of floods on wildlife habitat for flood and post-flood operations during a design and 1:100 year flood would be moderate in magnitude for species dependent on grassland (e.g., grassland songbirds and elk), but low in magnitude for species dependent on forest (e.g., olive-sided flycatcher) and wetland (e.g., northern leopard frog and sora) habitat. The residual cumulative effect during a 1:10 year flood would be low. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration.

Change in Movement

Cumulative Effects Pathway

The diversion of flood waters into the off-stream reservoir would retain wildlife habitat connectivity and movement corridors downstream of the diversion structure that would otherwise be temporarily flooded; however, the effects of flooding would be moved into the upland area of the off-stream reservoir during diversion. During flood and post-flood operations, the water contained in the off-stream reservoir and diversion channel has potential to create

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physical barriers that might temporarily hinder terrestrial wildlife movement in the LAA for certain species. Highway upgrades and construction at the Community of Harmony also have the potential to create physical barriers or sensory disturbance that might hinder wildlife movement in the RAA.

Mitigation for Cumulative Effects

Mitigation recommended for change in movement will reduce residual effects of the Project. Highway upgrades and construction at the Community of Harmony would be expected to implement industry-standard mitigation measures to reduce potential effects on wildlife movement in the RAA.

Residual Cumulative Effects

The Project is likely to have a greater temporary effect on ungulate movement than on movement of birds, amphibians, and grizzly bears during a flood. Flood water can act as a barrier to movement; however, it is somewhat permeable if animals, such as elk and grizzly bear, choose to swim across. Change in movement would depend on the magnitude of the flood because the extent of reservoir filling would affect whether animals go around or across the flooded area. Waterbirds might be attracted to the PDA during floods because the off-stream reservoir would be perceived as feeding or loafing habitat. The effects on movement would be temporary and would subside during post-flood operations. If occurring during a flood, then highway upgrades and construction at the Community of Harmony could contribute to a cumulative effect on wildlife movement; however, such effects would be limited to the duration of flood and post-flood maintenance operations.

With mitigation, the residual cumulative effect of future activities combined with the Project on wildlife movement would be moderate in magnitude during a design and 1:100 year flood, and low in magnitude during a 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration. Upgrading Highways 1, 22 and 8 would result in a continuous residual cumulative effect on wildlife movement in the RAA.

Change in Mortality Risk

Cumulative Effects Pathway

Flood and post-flood operations have the potential to result in increased mortality risk for wildlife in the PDA. Direct wildlife mortalities could result from destruction or abandonment of wildlife residences (e.g., nests, dens), drowning in diverted flood water, and animal-vehicular collisions. Mortality risk would vary depending on the magnitude of the flood and water depths. Highway upgrades and construction at the Community of Harmony also have the potential to increase

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wildlife mortality due to animal-vehicular collisions and the physical destruction of wildlife habitat features during construction (e.g., nests, dens, roosts).

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk during flood and post-flood operations will reduce residual effects of the Project. Although the specific mitigation measures that would be implemented for highway upgrades and construction at the Community of Harmony are unknown, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to SOMC.

Residual Cumulative Effects

The Project is predicted to increase wildlife mortality risk in the PDA during a flood. Whether the risk is low or moderate depends on the wildlife species affected and magnitude of the flood. Most of the flooded area would encompass wetlands and reclaimed vegetation that might be suitable breeding habitat for amphibians and ground-nesting migratory birds, respectively. Rising flood waters in the off-stream reservoir would remove migratory bird residences (e.g., nests) and young (e.g., eggs, nestlings, or fledglings), change the conditions required for amphibian larvae to develop, and introduce predatory fish that can prey on amphibians (e.g., eggs, larvae, or adults).

For large mammals (e.g., elk and grizzly bear), mortality risk would be less because of their mobility to avoid floods. During post-flood operations, maintenance activities might potentially result in a small increase in mortality risk due to a rise in traffic volume in the LAA and RAA for maintenance crews to travel to and from the Project area, thereby increasing the risk of animal-vehicular collisions. During diversion of flood waters, mortality risk in the floodplain of Elbow River, downstream of the diversion structure, would likely remain near existing condition levels.

If occurring during a flood, highway upgrades and construction at the Community of Harmony could contribute to a cumulative effect on wildlife mortality risk through increased traffic volume and the risk for animal-vehicular collisions; however, such effects would be limited to the duration of flood and post-flood maintenance operations.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on mortality risk would be moderate in magnitude for the design flood and 1:100 year flood, but low in magnitude for the 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding. Although cumulative effects on mortality risk would be short-term in duration because cumulative effects are limited to the construction phase, upgrading Highways 1, 22 and 8 would result in long-term effects on mortality risk.

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Significance of Cumulative Effects on Wildlife

The cumulative effects on wildlife attributable to the Project as well as all other future projects and activities is minor because most of the lands affected are previously disturbed, do not provide high suitability habitat and the effects will be temporary and limited to flood and post-flood operations. Future activities combined with the Project's predicted effects on habitat, movement and mortality risk will not threaten the long-term sustainability of wildlife in the RAA.

With mitigation and environmental protection measures, the cumulative effects on wildlife are predicted to be not significant.

Project Contribution to Cumulative Effects on Wildlife

The project contribution to cumulative changes to wildlife habitat, movement and mortality risk are minor, given the duration and temporary nature of flood and post-flood operations. The Project's contribution to cumulative effects during flood and post-flood operations is not expected to result in a change to the long-term sustainability of wildlife in the RAA.

Prediction Confidence

Prediction confidence for residual cumulative effects on wildlife and biodiversity is considered medium. Although the quality and quantity of existing conditions information used to predict Project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of wildlife within the RAA, as well as specific mitigation measures to be implemented by other future projects owners.

1.3.8.2 Cumulative Effects on Migratory Birds

Change in Habitat

Cumulative Effects Pathway

Flood operations have the potential to directly affect migratory bird habitat in the RAA through the temporary diversion of flood waters into the off-stream reservoir. The depth and extent of flood water would temporarily render habitat inaccessible in the reservoir for migratory birds that rely on grassland, shrubland, and wetland habitat. This change in habitat would be temporary and is expected to last up to 45 days and extend approximately up to 39 more days for the reservoir to recede and post-flood maintenance activities to occur. During post-flood operations, potential direct effects on wildlife habitat would include sediment deposition that would result in covering vegetation and reducing habitat suitability for wildlife in the drained reservoir as well as revegetation of the diversion channel, off-stream dam, and floodplain berm (which might be damaged or eroded during a flood). Sensory disturbance caused by

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maintenance equipment might contribute to temporary indirect effects on migratory birds (i.e., habitat avoidance or displacement).

Future projects will reduce migratory bird habitat availability in the RAA. Flood operations will act cumulatively to temporarily reduce habitat availability in the RAA. Post-flood operations will result in most of the habitat returning to dry operation conditions, but with some alterations due to left-over sediment in the reservoir.

Mitigation for Cumulative Effects

Mitigation recommended for change in habitat will reduce residual effects of the Project. Highway upgrades and construction at the Community of Harmony would be expected to implement industry-standard mitigation measures to reduce potential effects on migratory bird habitat in the RAA.

Residual Cumulative Effects

The amount of vegetation cover types in the RAA at baseline is shown in Table 1-22. About 52.8% of the RAA is native upland cover, 1.9% is wetland cover, and 43.7% is anthropogenic lands (which 9.1% is tame pasture or hay). During a design flood, the Project would contribute to a cumulative change in habitat; however, the change in habitat abundance (816 ha) would be temporary and is less than 1% of the upland and wetland cover types available in the RAA (Table 1-22). The most affected cover type in the RAA during a design flood is tame pasture and hay at 2%, followed by grassland at 1.7%. Migratory birds most affected by a design flood include grassland dependent species such as savannah sparrow; however, suitable grassland and tame pasture habitat exists outside the reservoir. The 1:00 and 1:10 year floods would have smaller cumulative residual effects on wildlife habitat.

During post-flood operations, the Project would cumulatively contribute a small change in native upland and wetland cover due to sediment deposition. During a design flood, sediment modeling predicts that 192.6 ha of the reservoir would be covered by sediment that is less than 3 cm deep, and 37.4 ha would be covered by sediment between 3 cm and 10 cm (see Volume 3B, Section 10.2.2). The quality of vegetation and wetlands post-flood would differ from baseline conditions. However, changes to overall migratory bird habitat abundance and suitability would be minor under these conditions. Sediment deposition of more than 10 cm is predicted to affect 145.4 ha in the reservoir and sediment deposition of greater than 1 m deep would affect 40.8 ha in the reservoir. Overall, higher sediment depths would have relatively greater effects on the suitability of migratory bird habitat; however, higher sediment depths (i.e., greater than 10 cm), would result in a small change in habitat (186.2 ha), representing 0.18% of the RAA.

In addition to the sediment in the reservoir, Project maintenance activities during post-flood operations could contribute to cumulative effects on migratory bird habitat in the reservoir due to sensory disturbance (i.e., indirect effect). However, mitigation applied to both Project and

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future activities is expected to reduce potential cumulative residual effects on migratory bird habitat.

The residual cumulative effect of future activities combined with the Project on migratory and non-migratory bird habitat for flood and post-flood operations during a design and 1:100 year flood would be moderate in magnitude for grassland dependent birds, but low for forest and wetland dependent birds. Residual cumulative effects would be low in magnitude during a 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration.

Change in Movement

Cumulative Effects Pathway

The diversion of flood waters into the off-stream reservoir are not likely to restrict the movement of migratory birds; however, floods can temporarily attract waterbirds because they might perceive the off-stream reservoir as a waterbody that has potential to provide feeding habitat (Roshier et al. 2002; Elphick and Oring 2003; King et al. 2010). Highway upgrades have limited potential to hinder or alter migratory bird movement in the RAA because there are no tall structures that would require birds to move around. The construction of the Community of Harmony would involve the addition of man-made lakes and/or wetlands that may act cumulatively with flood waters of the Project for migratory waterbird species.

Mitigation for Cumulative Effects

There are no mitigation measures recommended for change in movement (due to the Project) to migratory birds. Other future projects would be expected to implement industry standard mitigation measures to reduce the potential effects on migratory bird movement in the RAA.

Residual Cumulative Effect

Change in movement for waterbirds would depend on the magnitude of the flood because the extent of reservoir filling would affect whether waterbirds might be attracted and perceive the reservoir as feeding or loafing habitat. The effects on waterbird movement would be temporary and would subside during post-flood operations. If occurring during flood operations, the construction of the Community of Harmony could temporarily alter local waterbird movement in the RAA with an increase in potential wetland habitat. However, the final design of these wetlands is unknown (e.g., riparian cover, size) and whether the habitat created would be used by waterbirds. The effect is likely to be minor.

The residual cumulative effect of future activities combined with the Project on migratory bird movement would be low in magnitude for all floods. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration. Upgrading

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Highways 1, 22 and 8 would result in a continuous residual cumulative effect on migratory bird movement in the RAA.

Changes in Mortality Risk

Cumulative Effects Pathway

Flood and post-flood operations have the potential to result in increased mortality risk for migratory birds in the PDA. Direct migratory bird mortalities could result from destruction or abandonment of nests and drowning of eggs or young in diverted flood water. Mortality risk would vary depending on the magnitude of the flood and water depths. During post-flood operations, maintenance activities might potentially result in a small increase in mortality risk due to partial sediment clean up in the off-stream reservoir. Highway upgrades and construction at the Community of Harmony also have the potential to increase migratory bird mortality due to the physical destruction of migratory bird nests during vegetation clearing.

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk during post-flood operations will reduce residual effects of the Project. Although it is unknown the specific mitigation measures that would be implemented for Highway upgrades and construction at the Community of Harmony, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to migratory birds.

Residual Cumulative Effect

The Project is predicted to increase migratory bird mortality risk in the PDA during a flood. Whether the risk is low or moderate depends on the magnitude of the flood, and whether the bird is ground or tree nesting. Most of the flooded area would encompass reclaimed vegetation that might be suitable breeding habitat for ground-nesting migratory birds. Rising flood waters in the off-stream reservoir would remove nests and young (e.g., eggs, nestlings, or fledglings). Mortality risk in the floodplain of Elbow River, downstream of the diversion structure, would likely remain near existing conditions levels during diversion of flood waters. If occurring during a flood, then highway upgrades and construction at the Community of Harmony could contribute to a cumulative effect on migratory bird mortality risk through vegetation removal, however, such effects would be limited to the duration of a flood and post-flood maintenance operations.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on mortality risk for migratory birds would be moderate in magnitude for the design flood and 1:100 year flood, but low in magnitude for the 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding. Cumulative effects on mortality risk would be short-term in duration because cumulative effects are limited

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to the flood and post-flood operations phase, construction phase of the highway upgrades, and Community of Harmony project.

Significance of Cumulative Effects on Migratory Birds

The cumulative effects on migratory birds attributable to the Project as well as all other future projects and activities is minor because most of the lands affected are previously disturbed, do not provide high suitability habitat and the effects will be temporary and limited to flood and post-flood operations. Future activities combined with the Project's predicted effects on habitat, movement and mortality risk will not threaten the long-term sustainability of migratory birds in the RAA.

With mitigation and environmental protection measures, the cumulative effects on migratory birds are predicted to be not significant.

Project Contribution to Cumulative Effects on Migratory Birds

The project contribution to cumulative changes to migratory bird habitat, movement and mortality risk are minor, given the duration and temporary nature of flood and post-flood operations. The Project's contribution to cumulative effects during flood and post-flood operations is not expected to result in a change to the long-term sustainability of migratory birds in the RAA.

Prediction Confidence

Prediction confidence for residual cumulative effects on migratory birds is medium. Although the quality and quantity of existing conditions information used to predict Project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of migratory birds within the RAA, as well as specific mitigation measures to be implemented by other future projects.

1.3.8.3 Cumulative Effects on Species at Risk

Species-specific information regarding potential Project effects on federally listed species at risk and those species listed by COSEWIC are provided in Volume 3A and Volume 3B. The 22 species at risk are:

- horned grebe
- western grebe
- yellow rail
- long-billed curlew
- red knot
- short-eared owl

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- common nighthawk
- peregrine falcon
- olive-sided flycatcher
- loggerhead shrike
- bank swallow
- barn swallow
- Sprague's pipit
- Baird's sparrow
- bobolink
- rusty blackbird
- little brown myotis
- grizzly bear
- American badger
- western toad
- northern leopard frog
- western tiger salamander

During flood and post flood operations, residual effects of the Project on species at risk habitat, movement and mortality risk have potential to interact cumulatively with future projects which are discussed below.

Change in Habitat

Cumulative Effects Pathway

Flood operations have the potential to directly affect habitat species at risk in the RAA through the temporary diversion of flood waters into the off-stream reservoir. The depth and extent of flood water would temporarily render habitat inaccessible in the reservoir for most species at risk. This change in habitat would be temporary and is expected to last up to 45 days and extend approximately up to 39 more days for the reservoir to recede and post-flood maintenance activities to occur. During post-flood operations, potential direct effects on wildlife habitat would include sediment deposition that would result in covering vegetation and reducing habitat suitability for species at risk in the drained reservoir as well as revegetation of the diversion channel, off-stream dam, and floodplain berm (which might be damaged or eroded during a flood). Sensory disturbance caused by maintenance equipment might contribute to temporary indirect effects on species at risk (i.e., habitat avoidance or displacement).

Future projects will have already reduced habitat availability for species at risk in the RAA. Flood operations will act cumulatively to temporarily reduce habitat availability in the RAA. Post-flood operations will result in most of the habitat returning to dry operations conditions, but with some alterations due to left-over sediment in the reservoir.

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Mitigation for Cumulative Effects

Mitigation recommended for change in habitat will reduce residual effects of the Project. Highway upgrades and construction at the Community of Harmony would be expected to implement industry-standard mitigation measures to reduce potential effects on species at risk habitat in the RAA.

Residual Cumulative Effects

The amount of vegetation cover types in the RAA at baseline is shown in Table 1-22. About 52.8% of the RAA is native upland cover, 1.9% is wetland cover, and 43.7% is anthropogenic lands (which 9.1% is tame pasture or hay). During a design flood, the Project would contribute to a cumulative change in habitat, however, the change in habitat abundance (816 ha) would be temporary and represents less than 1% of the upland and wetland cover types available in the RAA (Table 1-22). The most affected cover type in the RAA during a design flood is tame pasture and hay at 2%, followed by grassland at 1.7%. Species at risk most affected by a design flood include long-billed curlew, short-eared owl, common nighthawk, peregrine falcon, Sprague's pipit, Baird's sparrow, bobolink, grizzly bear, American badger; however, suitable grassland and tame pasture habitat exists outside the off-stream reservoir. The 1:00 and 1:10 year floods would have smaller cumulative residual effects on wildlife habitat.

During post-flood operations, the Project would cumulatively contribute a small change in native upland and wetland cover due to sediment deposition. During a design flood, sediment modeling predicts that 192.6 ha of the reservoir would be covered by sediment that is less than 3 cm deep, and 37.4 ha would be covered by sediment between 3 cm and 10 cm (see Volume 3B, Section 10.2.2). The quality of vegetation and wetlands post-flood would differ from baseline conditions. However, changes to overall species at risk habitat abundance and suitability would be minor under these conditions. Sediment deposition of more than 10 cm is predicted to affect 145.4 ha in the reservoir and sediment deposition of greater than 1 m deep would affect 40.8 ha in the reservoir. Overall, higher sediment depths would have relatively greater effects on the suitability of species at risk habitat; however, higher sediment depths (i.e., greater than 10 cm), would result in a small change in habitat (186.2 ha), representing 0.18% of the RAA.

In addition to the sediment in the reservoir, Project maintenance activities during post-flood operations could contribute to cumulative effects on species at risk habitat in the reservoir due to sensory disturbance (i.e., indirect effect). However, mitigation applied to both Project and future projects is expected to reduce potential cumulative residual effects on species at risk habitat.

The residual cumulative effect of future activities combined with the Project on wildlife habitat for species at risk for flood and post-flood operations during a design and 1:100 year flood would be moderate in magnitude for those dependent on grassland cover types, but low for species

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at risk dependent on forest, shrubland, wetland and riparian cover types. For a 1:10 year flood, residual cumulative effects would be low in magnitude for all species at risk. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration.

Change in Movement

Cumulative Effects Pathway

The diversion of flood waters into the off-stream reservoir would retain wildlife habitat connectivity and movement corridors for species at risk downstream of the diversion structure that would otherwise be temporarily flooded; however, the effects of flooding would be moved into the upland area of the off-stream reservoir during diversion. During flood and post-flood operations, the water contained in the off-stream reservoir and diversion channel has potential to create physical barriers that might temporarily hinder terrestrial wildlife movement in the LAA for species at risk such as grizzly bear and American badger. Highway upgrades and construction at the Community of Harmony also have the potential to create physical barriers or sensory disturbance that might hinder terrestrial wildlife movement in the RAA for mammal and amphibian species at risk. The diversion of flood waters into the off-stream reservoir are not likely to restrict the movement of bird and bat species at risk; however, floods can temporarily attract waterbirds, such as horned grebe and western grebe, because they might perceive the area as a waterbody that has potential to provide feeding habitat (Roshier et al. 2002; Elphick and Oring 2003; King et al. 2010).

Mitigation for Cumulative Effects

Mitigation recommended for change in movement will reduce residual effects of the Project. Highway upgrades and construction at the Community of Harmony would be expected to implement industry standard mitigation measures to reduce potential effects on wildlife movement in the RAA.

Residual Cumulative Effect

Flood water can act as a barrier to movement; however, it is somewhat permeable if animals, such as grizzly bear, choose to swim across. Change in movement would depend on the magnitude of the flood because the extent of reservoir filling would affect whether species at risk go around or across the flooded area. Amphibian species at risk are unlikely to swim across flood waters due to avoidance of deep water, which is usually associated with increased predation risk (Lannoo 2005; SRD 2003). Waterbird species at risk might be attracted to the off-stream reservoir during floods because it would be perceived as feeding or loafing habitat. The effects on movement would be temporary and would subside during post-flood operations.

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If occurring during a flood, then highway upgrades and construction at the Community of Harmony could contribute to a cumulative effect on terrestrial wildlife movement for mammal and amphibian species at risk, however, such effects would be limited to the duration of flood and post-flood maintenance operations. Upgrades to Highways 1, 22 and 8 are more likely to have a relatively greater potential cumulative effect on less mobile species at risk (e.g., amphibians) and more common non-species at risk (e.g., deer and elk) than the Project and the construction of the Community of Harmony because increased traffic volumes might result in incremental sensory disturbance and altered movement patterns.

With mitigation, the residual cumulative effect of future activities combined with the Project on wildlife movement would be moderate in magnitude during a design and 1:100 year flood, and low in magnitude during a 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding and would be short-term in duration. Upgrading Highways 1, 22 and 8 would result in a continuous residual cumulative effect on wildlife movement for mammal and amphibian species at risk in the RAA.

Change in Mortality Risk

Cumulative Effects Pathway

Flood and post-flood operations have the potential to result in increased mortality risk for wildlife species at risk in the PDA. Direct wildlife mortalities could result from destruction or abandonment of residences (e.g., nests, dens), drowning in diverted flood water, and animal-vehicular collisions. Mortality risk would vary depending on the magnitude of the flood and water depths. Highway upgrades and construction at the Community of Harmony also have the potential to increase wildlife mortality for species at risk due to animal-vehicular collisions and the physical destruction of wildlife habitat features for species at risk during construction (e.g., nests, dens, roosts).

Mitigation for Cumulative Effects

Mitigation recommended for change in mortality risk during flood and post-flood operations will reduce residual effects of the Project. Although it is unknown the specific mitigation measures that would be implemented for highway upgrades and construction at the Community of Harmony, standard mitigation is expected to be implemented (e.g., pre-construction bird nest surveys), which would reduce incremental increases in mortality risk to species at risk.

Residual Cumulative Effect

The Project is predicted to increase wildlife mortality risk for species at risk in the PDA during a flood. Whether the risk is low or moderate depends on the wildlife species affected and magnitude of the flood. Most of the flooded area would encompass wetlands that might be suitable breeding habitat for horned grebe, western grebe, yellow rail, western toad, northern

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leopard frog, and western tiger salamander. The flooded area would also cover reclaimed grassland suitable for ground-nesting bird species at risk such as long-billed curlew and bobolink. The risk of direct mortality—due to nest flooding for tree-nesting bird species at risk (e.g., olive sided flycatcher) or flooding of roosts for little brown myotis—is lower due to higher heights, as well as most forest habitat occurring along Elbow River. Mortality risk in the floodplain of Elbow River, downstream of the diversion structure, would likely remain near existing conditions levels during diversion of flood waters.

Rising flood waters in the off-stream reservoir would remove bird residences (e.g., nests) and young (e.g., eggs, nestlings, or fledglings), change the conditions required for amphibian larvae to develop, and introduce predatory fish that can prey on amphibian species at risk (e.g., eggs, larvae, or adults). For mammal species at risk (e.g., grizzly bear and American badger), mortality risk would be less because of their mobility to avoid floods. During post-flood operations, maintenance activities might potentially result in a small increase in mortality risk due to a rise in traffic volume in the LAA and RAA for maintenance crews to travel to and from the Project area, thereby increasing the risk of animal-vehicular collisions.

If occurring during a flood, then highway upgrades and construction at the Community of Harmony could contribute to a cumulative effect on wildlife mortality risk through increased traffic volume and the risk for animal-vehicular collisions and vegetation removal. However, the majority of animal-vehicular collisions involve ungulates, and no species at risk such as grizzly bear or American badger, have been identified in a collision along Highways 1, 22, and 8 (Alberta Transportation 2017). Based on the existing animal-vehicular collision data, the increased mortality risk due to traffic associated with future projects might be minor for species at risk. Residual cumulative effects would be limited to the duration of a flood and post-flood maintenance operations.

With mitigation, the incremental contribution of future activities combined with the Project's residual effect on mortality risk would be moderate in magnitude for the design flood and 1:100 year flood, but low in magnitude for the 1:10 year flood. Residual cumulative effects would occur at a single irregular event at the time of flooding. Although cumulative effects on mortality risk for species at risk would be short-term in duration because cumulative effects are limited to the construction phase, upgrading Highways 1, 22 and 8 would result in long-term effects on mortality risk for grizzly bear and American badger.

Significance of Cumulative Effects on Species at Risk

The cumulative effects on species at risk attributable to the Project as well as all other future projects and activities is minor because most of the lands affected are previously disturbed, do not provide high suitability habitat and the effects will be temporary and limited to flood and post-flood operations. Future activities combined with the Project's predicted effects on habitat,

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movement and mortality risk will not threaten the long-term sustainability of species at risk in the RAA.

With mitigation and environmental protection measures, the cumulative effects on species at risk are predicted to be not significant.

Project Contribution to Cumulative Effects on Species at Risk

The project contribution to cumulative changes to species at risk habitat, movement and mortality risk are minor, given the duration and temporary nature of flood and post-flood operations. The Project's contribution to cumulative effects during flood and post-flood operations is not expected to result in a change to the long-term sustainability of species at risk in the RAA.

Prediction Confidence

Prediction confidence for residual cumulative effects on species at risk is considered medium. Although the quality and quantity of existing conditions information used to predict Project residual effects provides a relatively high level of confidence, there is some uncertainty associated with the distribution and abundance of species at risk within the RAA, as well as specific mitigation measures to be implemented by other future projects.

1.3.9 Land Use Management

1.3.9.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on land use and management during flood and post-flood operations. Residual effects are predicted to be not significant. Table 1-24 lists the other projects that have the potential to act cumulatively with residual environmental effects from the Project during flood and post-flood operations.

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Table 1-24 Interactions with the Potential to Contribute to Cumulative Effects on Land Use and Management, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects	
	Change in Land Use	Change in Parks and Protected Areas and Unique Sites or Special Features
Past and Present Projects and Physical Activities (Dry Operations)	✓	-
Future Physical Activities		
The Community of Harmony - Stage 2 and 3	-	-
Upgrades to Highways 1, 8 and 22	-	-
Rocky View County Springbank Master Drainage Plan	-	-
City of Calgary	-	-

The upgrades to Highways 1, 8 and 22 occur within the RAA defined for land use and management. However cumulative effects on land use and management are not anticipated to result from these activities because the upgrades to Highway 1, 8 and 22 would be expected to occur within the existing right of way and would, therefore, not result in changes to current land use.

During flood and post-flood operations there would be an incremental change to land use and management. However, additional changes from the other activities during a flood are not anticipated and their contribution has already been accounted for in construction and dry operations. In the absence of additional effects from other activities during flood and post-flood operations, there is no pathway for cumulative effects.

1.3.10 Traditional Land and Resource Use

1.3.10.1 Project Residual Effects Likely to Act Cumulatively

the Project is anticipated to have adverse residual effects on TLRU during flood and post-flood operations, but the effects are not significant.

Table 1-25 lists the projects that have potential to act cumulatively with residual environmental effects from the Project.

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Table 1-25 Interactions with the Potential to Contribute to Cumulative Effects on Traditional Land and Resource Use, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects		
	Change in availability of traditional resources for current use	Change in access to traditional resources or areas for current use	Change in current use sites or areas within the area of permanent structures
Past and Present Projects and Physical Activities (Dry Operations)	✓	-	-
Future Physical Activities			
The Community of Harmony - Stage 2 and 3	✓	-	-
Upgrades to Highways 1, 8 and 22	✓	-	-
Rocky View County Springbank Master Drainage Plan	-	-	-
City of Calgary	-	-	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.			

Detailed construction schedules are not available for the Community of Harmony and the upgrades to Highway 1, 8 and 22. Therefore, it is conservatively assumed that construction may still be occurring in 2022, at the same time as when the Project first becomes operational to mitigate floods in the Elbow River.

During flood and post-flood operations, low magnitude residual effects on access to traditional resources or areas are anticipated; however, additional changes from other future activities during a flood are not anticipated and their contribution has already been accounted for in construction and dry operations. In the absence of additional effects from other future activities during flood and post-flood operations, there is no pathway for cumulative effects on access to traditional resources or areas for current use.

Adverse residual effects on current use sites and areas from the Project are limited to the PDA and therefore are not anticipated to act cumulatively with the residual effects of future developments in the TLRU RAA.

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1.3.10.2 Change in Availability of Traditional Resources for Current Use

Cumulative Effects Pathways

Potential cumulative effects on the availability of traditional resources for current use due to future projects and activities have similar effects as those identified for the Project. The following describes the potential pathways that could affect the availability of traditional resources. Only those effect pathways where related VCs have identified a potential for residual effects of the Project to interact cumulatively with other projects and physical activities have been included in the discussion. The information presented in this section is in response to potential interactions and pathways identified by Indigenous groups.

Change in Habitat (Vegetation, Wildlife)

The residual effects of the Project could act cumulatively with the residual effects of future projects to create changes in habitat for traditionally used plant and animal species; such changes could also affect hunting, trapping, and plant gathering activities. Changes may occur from temporary inundation (i.e., inaccessible) and/or permanent loss or alteration of vegetation and wildlife habitat, and sensory disturbance.

Change in Movement Patterns (Wildlife)

The residual effects of the Project could act cumulatively with the residual effects of future projects to change movement patterns of wildlife; such a change could also affect hunting and trapping activities. During flood and post-flood operations, the water contained in the off-stream reservoir and diversion channel has potential to create physical barriers that might temporarily hinder terrestrial wildlife movement in the LAA for certain species. Highway upgrades and construction at the Community of Harmony also have the potential to create physical barriers or sensory disturbance that might hinder wildlife movement in the RAA.

Changes in Mortality (Wildlife)

The residual effects of the Project could act cumulatively with the residual effects of future projects to change mortality risk in wildlife; such a change could affect the availability of traditional resources for current use. Changes may occur from destruction or abandonment of wildlife residences (e.g., nests, dens), drowning in diverted flood water, and animal-vehicular collisions.

Change in Country Foods

The residual effects of the Project on traditionally harvested wildlife, fish and vegetation resources as described above could act cumulatively with the residual effects of future projects and result in corresponding effects on the consumption of country foods by Indigenous groups.

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The assessment of effects on public health concludes that there are no residual effects on human health from consumption of country foods during flood and post-flood operation.

Change in Drinking Water

No pathways for cumulative effects on surface water quality or hydrogeology have been identified as a result of flood and post-flood operations; therefore, cumulative effects on the traditional use of water, including drinking water, are not anticipated.

Mitigation for Cumulative Effects

Project mitigation and monitoring measures to reduce potential Project effects on availability of traditional resources for current use are presented in Volume 3B, Section 14.2. Although it is unknown the specific mitigation measures that would be implemented by other future projects to reduce potential residual cumulative effects in the RAA, highway upgrades and construction of the Community of Harmony would be expected to implement industry-standard mitigation measures. No specific recommendations or mitigation regarding cumulative effects on the availability of traditional resources for current use were identified by Indigenous groups in the TUS reports or through the results of the Indigenous engagement program.

Residual Cumulative Effects

The Project is predicted to alter wildlife habitat, movement and increase wildlife mortality risk in the PDA during a flood, which in turn may affect the availability of traditional resources for current use. Cumulative effects on wildlife movement and mortality risk would vary depending on the magnitude of the flood and water depths and would depend on the size and mobility of the wildlife species affected. If occurring during a flood, then highway upgrades and construction of the Community of Harmony could contribute to a cumulative effect on wildlife habitat, movement and mortality risk; however, such effects would be limited to the duration of flood and post-flood maintenance operations. Cumulative effects on wildlife habitat, movement and mortality risk are not anticipated to threaten the long-term sustainability of wildlife in the RAA (see Section 1.3.8). Similarly, cumulative effects on vegetation and wetlands, when considered in a regional context with existing and future projects and activities, is expected to be relatively minor because the amount of vegetation and wetlands affected due to floods is small compared to the availability of similar vegetation and wetlands remaining in the RAA. Cumulative effects on vegetation and wetlands are not anticipated to threaten the long-term availability of traditional vegetation resources for current use.

It is acknowledged that appropriate conditions for current use entail more than the availability of traditional resources and that Indigenous groups may choose not to pursue TLRU activities near the Project or other future projects in the RAA for a variety of personal, practical, aesthetic and spiritual reasons. No residual effects on the acoustic environment are anticipated; therefore, there is no pathway for cumulative effects. Given the limited potential for future projects to

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interact with the residual effects of the Project on soils and terrain, air quality and climate, either temporally or spatially, residual cumulative effects on TLRU are not anticipated.

With the combined application of mitigation measures and with the engagement of Indigenous groups during Project planning and the planning of other future projects, the residual cumulative effect on the availability of traditional resources for current use would be moderate in magnitude during a design and 1:100 year flood, and low in magnitude during a 1:10 year flood. Residual cumulative effects would occur as a single irregular event at the time of flooding and would be primarily short-term in duration. Upgrading Highways 1, 22 and 8 would result in a continuous, long-term residual cumulative effect on the availability of traditional resources for current use in the RAA.

1.3.10.3 Significance of Cumulative Effects

The cumulative effects on TLRU attributable to the Project as well as other future projects and activities are considered minor because most of the lands affected are previously disturbed and the effects will be temporary and limited to flood and post-flood operations. As such, future activities combined with the Project's predicted effects on the availability of traditional resources for current use are not anticipated to critically reduce or eliminate current use from the RAA as a result of flood and post-flood operations.

With mitigation and environmental protection measures and engagement, the cumulative effects on TLRU are predicted to be not significant.

1.3.10.4 Project Contribution to Cumulative Effects

The Project contribution to cumulative changes to the availability of traditional resources for current use are minor, given the duration and temporary nature of flood and post-flood operations. The Project's contribution to cumulative effects during flood and post-flood operations is not expected to result in a change to the long-term sustainability of wildlife and vegetation in the RAA.

1.3.10.5 Prediction Confidence

Based on the information received from potentially affected Indigenous groups, reliance on assessments of other VCs of relevance to TLRU, and understanding of applicable mitigation measures and future projects, the prediction confidence for residual cumulative effects on TLRU is moderate. Given the qualitative and subjective nature of assessing TLRU, the views of Indigenous communities may differ from the findings of this assessment.

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1.3.11 Public Health

1.3.11.1 Project Residual Effects Likely to Act Cumulatively

The Project has the potential to have adverse residual effects on public health. The potential health concerns include the inhalation of fine particulate matter from wind-blown dust from dry sediments in the off-stream reservoir. Mitigation measures such as applying tackifiers (i.e., a sprayable erosion control product that bonds with the soil surface and creates a porous and absorbent erosion resistant blanket, lasting up to 12 months) can effectively reduce fine particulate matter to negligible levels in the air. There is also the concern that naturally occurring inorganic mercury in the flooded reservoir could be converted into methylmercury, and accumulate up the aquatic food chain. These health concerns were determined to be not significant during the flood and post-flood phases of the Project.

Table 1-26 lists the projects that have the potential to act cumulatively with residual environmental effects from the Project, as they relate to public health. There are no projects that act cumulatively with the Project as they relate to public health, since there are no significant changes to human health from inhalation of fine particulate matter. The listed projects and physical activities are also not associated with the production or emission of methylmercury in the terrestrial or aquatic environment, and would have no influence on methylmercury in the food chain. Consequently, there is no pathway for cumulative effects with the Project during the

Table 1-26 Interactions with the Potential to Contribute to Cumulative Effects on Public Health, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Human Health
Past and Present Projects and Physical Activities (Dry Operations)	-
Future Physical Activities	
The Community of Harmony - Stage 2 and 3	-
Upgrades to Highways 1, 8 and 22	-
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-

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1.3.12 Infrastructure and Services

1.3.12.1 Project Residual Effects Likely to Act Cumulatively

The Project is anticipated to have adverse residual effects on infrastructure and services during flood and post-flood operations. Residual effects would be not significant. Table 1-27 lists the other projects that have the potential to act cumulatively with residual environmental effects from the Project during flood and post-flood operations.

Table 1-27 Interactions with the Potential to Contribute to Cumulative Effects on Infrastructure and Services, Flood and Post-Flood

Other Projects and Physical Activities with Potential for Cumulative Environmental Effects	Environmental Effects
	Change in Transportation Infrastructure and Services
Past and Present Projects and Physical Activities (Dry Operations)	✓
Future Physical Activities	
The Community of Harmony - Stage 2 and 3	✓
Upgrades to Highways 1, 8 and 22	✓
Rocky View County Springbank Master Drainage Plan	-
City of Calgary	-
NOTES: ✓ = Other projects and physical activities whose residual effects are likely to interact cumulatively with Project residual environmental effects. - = Interactions between the residual effects of other projects and residual effects of the Project are not expected.	

During a flood and post flood operations, there would be an incremental change to transportation infrastructure and services from the Project; however, additional changes from the other activities during a flood are not anticipated. In the absence of additional effects from the other activities during flood and post flood operations, there is no pathway for cumulative effects.

1.3.12.2 Change in Transportation Infrastructure and Services

Cumulative Effects Pathway

During a design flood, parts of Springbank Road east of Highway 22 would be submerged and traffic would be rerouted to Range Road 40 and Township Road 250, potentially causing traffic disruptions and placing additional demands on transportation infrastructure and services. Once floodwaters have receded sufficiently, affected roadways and bridges would be inspected for



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damage. If repairs were necessary, Springbank Road would remain out of service until repairs were completed. Highway 22 might sustain minor wave damage to the roadway sideslopes, which would require single-lane closures during repairs.

Following the design flood, accumulations of sediment and debris would be removed from the diversion channel and, possibly, the off-stream reservoir to restore to their original level of functionality (sediment would be removed if it risks impairing water flow during a future flood). The waste sediment and debris would be trucked to a suitable landfill facility and this would create additional traffic.

Should upgrades to Highways 1,8 or 22 or construction at the Community of Harmony occur at the same time as a flood, then the potential exists for a cumulative effect to the disruption of local traffic.

Mitigation for Cumulative Effects

Mitigation measures to reduce the Project's effects on transportation infrastructure and services during flood and post-flood operations are detailed in Volume 3B, Section 16.2.2.2. Alberta Transportation will be responsible for any upgrades to Highways 1, 8 and 22 and will, therefore, coordinate traffic management in the event of a flood. Alberta Transportation will also coordinate with Rocky View County.

Residual Cumulative Effect

During a design flood, the rerouted traffic from Springbank Road to Range Road 40 and Township Road 250 would cause traffic disruptions and place additional demands on transportation infrastructure and services. The project design incorporates upgrades of Range Road 40 and Township Road 250 to accommodate extra traffic. Highway 22 and Township Road 244 will be raised above the design flood elevation where they intersect. RR 40 and Township Road 250 have the capacity to handle additional traffic created by the detour. However, should upgrades be occurring at Highways 1, 8 or 22 at the time of the flood, these may add to the temporary traffic disruptions in the area.

After floodwaters have receded sufficiently, affected roadways and bridges would be inspected and repaired, if required. Following a design flood, it is estimated that the truck-haul traffic volumes created by any trucking of debris would be within the capacity of the existing road infrastructure, or the future infrastructure in place at the time of the flood. Traffic disruption associated with post-flood operations would be temporary.

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1.3.12.3 Significance of Cumulative Effects

The cumulative effect to transportation infrastructure be temporary would not result in a substantial decrease in the quality of a service provided, on a persistent and ongoing basis, which cannot be mitigated with current or anticipated programs, policies, or mitigation measures; the residual cumulative effect is not significant for the flood and post-flood phases.

1.3.12.4 Project Contribution to Cumulative Effects

Of the potential activities that may be occurring during flood and post-flood operations, the Project will likely contribute most to the disruption in transportation infrastructure due to the partial flooding of Springbank Road. The Project has been designed to protect infrastructure in the City of Calgary from damage in the event of a flood. The potential flooding of part of Springbank Road is integral to the design of the Project.

1.3.12.5 Prediction Confidence

Prediction confidence is considered moderate. The effects from the Project during a flood are reasonably well understood; however, it is unknown whether highway upgrades or construction at the Community of Harmony would be occurring during a flood.

1.4 CONCLUSIONS

Table 1-28 summarizes the significance conclusions of Project contribution to cumulative effects for each assessed VC and each scenario. Valued components that show “no interactions” have no cumulative interactions and so no further detailed assessment is done. Valued components showing “not assessed” were not assessed for cumulative effects at all for that scenario.

Valued components not assessed in any way for cumulative effects (and so do not appear in the table) are acoustics, employment and economy, historical resources.

Proposed mitigation for residual effects from the Project for all assessed VCs is adequate to mitigate potential Project contribution to cumulative effects.

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Table 1-28 Significance Conclusions for Project Contribution to Cumulative Effects

Valued Component	Construction and Dry Operations	Flood and Post-flood
Air quality and climate	not significant	not significant
Hydrogeology	no interactions	no interactions
Hydrology	not assessed	no interactions
Surface water quality	no interactions	no interactions
Aquatic ecology	not significant	no interactions
Terrain and soils	not significant	no interactions
Vegetation and wetlands	not significant	not significant
Wildlife and biodiversity	not significant	not significant
Land use management	not significant	no interactions
Traditional land and resource use	not significant	not significant
Public health	no interactions	no interactions
Infrastructure and services	not significant	not significant

A significance conclusion for overall cumulative effects, which is the effects from all possible sources (i.e., projects and physical activities) on VCs is not provided because, given the context discussed in Section 1.1.5, such a conclusion would not be meaningful. The existing region is no longer largely reflective of dominant retention of natural post-glacial natural values; instead, it is an extensively transformed landscape by purposeful intent over more than one hundred years of settlement and development. All lands are zoned to accept and manage either human land use or natural values. The Project contributes not at all or minimally so to a change locally or to the overall state of the region (i.e., the overall cumulative effect) during its multiple decades of operational readiness. The one unique exception is that the Project's intent by design, and for a relatively brief period of time, is a positive effect by reducing the outcomes of a major natural flood on some of the human and natural values in that region.

1.5 REFERENCES

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