APPENDIX IR302-1 DRAFT SURFACE WATER MONITORING PLAN

ALBERTA TRANSPORTATION SPRINGBANK OFF-STREAM RESERVOIR PROJECT
RESPONSE TO NRCB AND AEP SUPPLEMENTAL INFORMATION REQUEST 1, JULY 28, 2018

Appendix IR302-1 Draft Surface Water Monitoring Plan
May 2019

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SPRINGBANK OFF-STREAM RESERVOIR PROJECT
Draft Surface Water Monitoring Plan

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Alberta Transportation

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Abbreviations

ACO	Aboriginal Consultation Office
AEP	Alberta Environment and Parks
BSP	biologically significant period
BRBC	Bow River Basin Council
CCME	Canadian Council of Ministers of the Environment
CEAA	Canadian Environmental Assessment Act
CRA	Commercial, Recreational, and Aboriginal
ERWP	Elbow River Watershed Partnership
EIA	Environmental Impact Assessment
DFO	Fisheries and Oceans Canada
FRL	fish research license
LWD	large woody debris
LAA	local assessment area
m^3/s	meters cubed per second
mg/L	milligram per liter
NTU	nephelometric turbidity units
PDA	Project development area
the Project	Springbank Off-stream Reservoir Project
QAES	qualified aquatic environment specialist
RAA	regional assessment area
RAP	restricted activity period

SSRB	South Saskatchewan River Basin
SAR	species at risk
SOMC	species of management concern
SWQG	surface water quality guideline
TSS	total suspended sediment or total suspended solids
TLRU	traditional land and resource use
TUS	Traditional Use Study
VC	valued component

Glossary

bankfull	the point where a river channel is full and stream flows are at the incipient point of flooding.
bedload	the river sediments that are subject to movement from stream flows.
dry operations	Phase of the Springbank Project when the off-stream reservoir is empty of retained water.
geomorphology	the science of geological structures and related physical features; the geomorphology of rivers includes the science of river sediments and how they interact with stream flow.
loadform	spreadsheet formatted to be accepted into an electronic database.
methylmercury	Organic form of mercury that forms from bacterial transformation of elemental mercury bioaccumulates in aquatic organisms.
navigable water	streams and rivers that have adequate water depths and conditions for navigating a boat or water craft.
suspended sediment	sediment particles that can remain suspended in flowing water.
total Kjeldahl nitrogen	the sum nitrogen concentration in a water sample analyzed for organic nitrogen, ammonia and ammonium using a method developed by Johan Kjeldahl.

yield	A quantitative measure for an amount of substance (e.g., sediment) moving past a point in the river for a specified period of time.

1.0 INTRODUCTION

This document is the draft Surface Water Mitigation and Monitoring Plan (the draft Plan) for construction and operation of the Springbank Off-stream Reservoir Project (the Project). Based on the EIA conclusions, and associated regulatory and legislative requirements, mitigation and monitoring of hydrology, water quality and aquatic resources will be undertaken for the Project.

Because of the related and overlapping nature among the hydrology, water quality and aquatic ecology disciplines, this draft Plan integrates monitoring elements of each into a single program. This approach reduces redundancies and improves collaboration among these related disciplines. Many monitoring parameters (e.g., suspended sediment) are important for all three disciplines, therefore proposed monitoring components are selected in a manner to maximize their value for each. This includes selecting monitoring locations, known regulatory requirements, and operational needs.

This draft Plan is based on assumed regulatory requirements for approvals and authorizations specific to the Project; however, additional explicit monitoring details will be determined once approval conditions are provided.

1.1 GOALS AND OBJECTIVES

The objective is to collect data needed to operate the Project (e.g., flood flow diversion), adaptively manage activities (e.g., reservoir drawdowns and water release), and maintain compliance with regulatory requirements (e.g., meet water quality standards or comply with Federal *Fisheries Act* requirements). The hydrology, water quality and aquatic ecology monitoring components have overlapping but sometimes separate objectives as summarized below:

The objective of the hydrology component of the monitoring plan to collect stream flow and water surface elevation data in Elbow River, the off-stream reservoir and low-level outlet l in order to manage:

- the diversion of flood flows from Elbow River (e.g., collect information to know when to initiate opening and closing the service spillway gates and the diversion inlet)
- filling the off-stream reservoir
- draining the off-stream reservoir and release water to Elbow River without remobilizing sediments or affecting water quality in the river

The objective of the water quality component is to determine whether the water in the off-stream reservoir will, upon release, affect Elbow River water quality in a manner that:

- meets or exceeds an implemented water quality objective
- meets or exceeds site-specific water quality guideline for the protection of aquatic life
- contravenes a watershed management target or causes acute or chronic toxicity to aquatic life
- changes the trophic status of Elbow River

The objectives of the aquatic ecology component are to assess compliance with regulatory permits, as well as assess the effectiveness of the design of Project components and mitigations to protect the aquatic environment.

Three types of monitoring are outlined in this draft Plan: construction monitoring, compliance monitoring and operational monitoring, as defined below.

Construction Monitoring

Construction monitoring is conducted when any instream construction activities are taking place. It also includes activities along the banks of Elbow River that may generate runoff and sediment through surface disturbance and potentially result in suspended sediments in the aquatic environment. Construction monitoring provides feedback on the effectiveness of proper construction practices and relevant environmental mitigations to maintain compliance with water quality sediment guidelines and approval conditions pertaining to construction.

Compliance Monitoring

Compliance monitoring is conducted to ensure the Project is constructed and functions in compliance with the Alberta *Water Act* approval and Canada *Fisheries Act* authorization. A summary is provided within this draft Plan and details will be updated once relevant conditions associated with approvals are available.

Operational Monitoring

Operational monitoring will occur in all Project phases and considers elements that are outlined in regulatory criteria (e.g., water quality) or predictions in the EIA and provides feedback to manage the Project within set criteria (e.g., when Elbow River flows are high enough to initiate flow diversion or low enough to initiate slow release of water from the off-stream reservoir).

2.0 REGULATIONS, APPROVALS AND GUIDELINES

Upon Project approval by Alberta Environment and Parks (AEP) and the Canadian Environmental Assessment Agency (CEA Agency), additional approvals and authorizations will be obtained for specific Project components for their construction and operation (e.g., *Fisheries Act* authorization for permanently altering or destroying fish habitat).

Each approval and authorization will include conditions so the Project complies with relevant regulatory obligations (e.g., the *Fisheries Act* authorization must comply with the Act's provision for fish passage). The draft Plan is structured to demonstrate how the Project will comply with these requirements. Additional approval conditions may apply and will be determined through the regulatory process. The relevant regulatory authority of different legislative bodies is outlined in Table 2-1.

Table 2-1 Legislation Applicable to Project Water Mitigation and Monitoring Requirements.

Legislation	Regulatory Agency	Resource
Alberta Environmental Protection and Enhancement Act	Alberta Environment and Parks	Environmental protection and public interest
Canadian Environmental Assessment Act	Canadian Environmental Assessment Agency (Environment and Climate Change)	Environmental protection and public interest
Alberta Water Act	Alberta Environment and Parks	Waterbodies, wetlands and aquatic environments
Alberta Fisheries Act	Alberta Environment and Parks	Conservation of fish stocks and fish handling/capture methods
Alberta Public Lands Act	Alberta Public Lands	Crown claimable land including waterbodies within bed and shore
Canada Fisheries Act	Department of Fisheries and Oceans	Commercial, recreational and Aboriginal (CRA) fisheries, or fish that support such a fishery; habitat that supports a CRA
Navigation Protection Act	Transport Canada	Protection of navigability in waterbodies and water ways.

2.1 PROVINCIAL AGENCY RESPONSIBILTIES AND REPORTING REQUIREMENTS

2.1.1 Construction and Dry Operations

Alberta Transportation will be responsible for final development of the Plan and implementation during the construction phase and for a period of three years post-construction during the dry operations phase of the Project. After that, AEP will implement the Plan during dry operations. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

2.1.2 Flood and Post-Flood Operations

AEP will be responsible for implementing the Plan during both flood and post-flood operation phases of the Project. The reporting requirements (i.e., number of reports, timing) will be determined following Project approval.

3.0 REGULATORY, INDIGENOUS AND PUBLIC STAKEHOLDER INPUT

Engagement with stakeholders, including landowners, municipalities, infrastructure companies and others has been ongoing since the fall of 2014. Alberta Transportation's engagement with Indigenous groups also began in 2014 and with the five Treaty 7 First Nations in accordance with The Government of Alberta's Guidelines on Consultation with First Nations on Land and Natural Resource Management (2014) and the First Nation Consultation Plan approved by the Aboriginal Consultation Office (ACO).

3.1 GROUPS ENGAGED

Table 3-1 lists the Indigenous groups that have been engaged on the Project.

Table 3-1 Indigenous Groups Identified for Engagement

Indigenous Group or Organization	Distance from Project
Treaty 7 Nations	
Tsuut'ina Nation	619 m
Stoney Nakoda Nations (Bearspaw First Nation, Chiniki First Nation, and Wesley First Nation)	28 km
Siksika Nation	78 km
Piikani Nation	144 km
Kainai First Nation (Blood Tribe)	170 km
Treaty 6 Nations	
Ermineskin Cree Nation	204 km
Louis Bull Tribe	207 km
Montana First Nation	194 km
Samson Cree Nation	198 km
Other	
Foothills Ojibway	No Reserve
Ktunaxa Nation	180 km
Métis Nation of Alberta, Region 3	N/A
Métis Nation British Columbia	N/A

3.1.1 Issues Identified

Issues, concerns and recommendations related to effects of the Project were reported by Indigenous groups through the Indigenous engagement program. Engagement with the Indigenous groups potentially affected by the Project is ongoing and will continue as the Project progresses. Alberta Transportation will review Traditional Use Study (TUS) reports as they are made available by Indigenous groups. Relevant traditional land and resource use (TLRU) information, concerns, and recommendations received after the EIA was filed will be used for project planning and implementation purposes, where applicable.

Generally, issues and concerns related to effects from the Project on hydrology, water quality, and aquatic ecology, as reported by Indigenous groups through the review of Project-specific and publicly-available TLRU information, include:

- permanent alteration of flow in Elbow River
- increase of sedimentation in Elbow River
- methylmercury
- groundwater-surface water interactions
- water temperature changes from the low-level outlet
- change in important fish habitat components (e.g., spawning and overwintering habitat) due to the presence of the project and associated changes in Elbow River flows
- fish passage issues through the service spillway during construction and low flow dry operation periods
- fish stranded in the off-stream reservoir when the water is released back into Elbow River

3.1.2 Economic Opportunities

Alberta Transportation is committed to Indigenous participation in the Project, including training, employment and contracting opportunities. Alberta Transportation is preparing an “Indigenous Participation Plan” for the Project. The goal of this Plan is to create training and contracting opportunities with interested Indigenous groups potentially affected by the Project. Alberta Transportation aims to obtain Indigenous comment and feedback on the draft Plan, the final draft of which will identify how that feedback has been incorporated, as appropriate.

4.0 PROJECT DESCRIPTION

The Project consists of the construction and operation of an off-stream reservoir to divert and retain a portion of Elbow River flows during a flood (Figure 4-1). The diverted water will be released back to Elbow River in a controlled manner after the flows in Elbow River decrease sufficiently to accommodate the release of water from the reservoir. The reservoir will not hold a permanent pool of water.

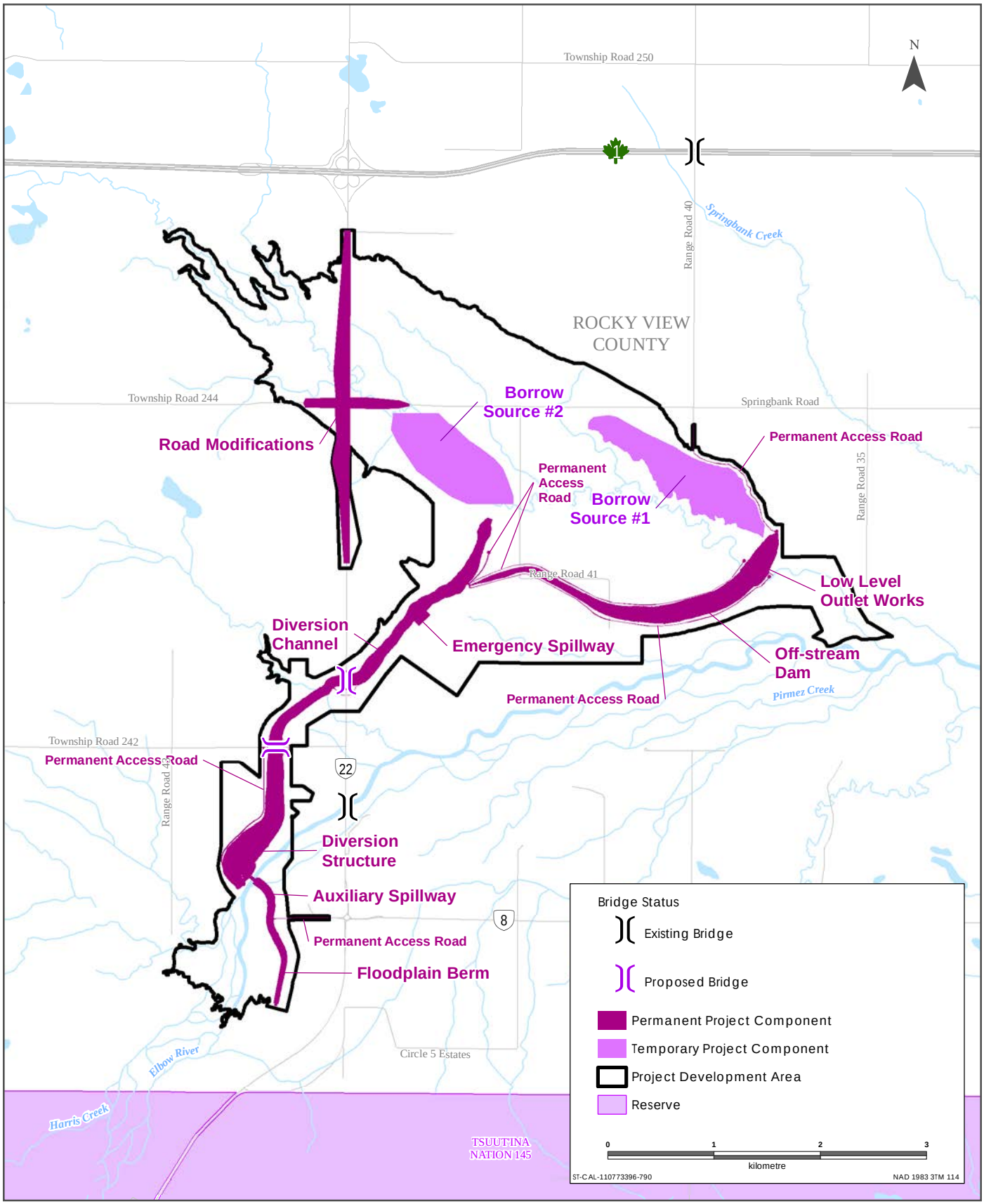
4.1 PROJECT COMPONENTS

The primary Project components include:

- a diversion structure on the main channel and floodplain of Elbow River
- a diversion channel to transport partially diverted floodwater into the off-stream reservoir
- a dam to temporarily retain the diverted floodwater in the reservoir
- a low-level outlet in the dam to return retained water through the existing unnamed creek and back to the river when AEP Operations determines conditions are appropriate.

These primary components are described further in the following sections and shown in Figure 4-1. Construction of the primary components requires other Project infrastructure including:

- new roadworks and bridges
- utility relocations



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Main Components of the Project

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The primary Project components will be constructed and operated under four distinct phases. The surface water monitoring plan will begin during the construction phase and continue into operational phases. Specific types of monitoring will overlap each operational phase (e.g., Elbow River flow monitoring will occur during all operational phases). The four phases are as follows:

- Construction of primary Project components and facilities related to structures and activities in the aquatic environment.
- Dry operations refers to routine operations when Elbow River flows are less than flood stage and there is no water in the off-stream reservoir.
- Flood operations refers to operations when Elbow River flows are greater than 160 m^3/s and water is being partially diverted from the river into the off-stream reservoir.
- Post-flood conditions refers to operations the release of water from the off-stream reservoir and maintenance activities in the PDA to prepare the infrastructure for the next flood that would have a portion of its waters directed into the off-stream reservoir (from a decade to decades in the future).

4.1.1 Diversion System

The diversion system consists of five main elements (Figure 4-1):

- The debris deflector consists of vertical metal tubing on a concrete foundation to reduce the risk of infrastructure damage and operating failure of Project components, including diversion inlet, diversion channel, off-stream reservoir and dam.
- The floodplain berm is located on the south floodplain of Elbow River. In concert with the auxiliary spillway, it acts to constrain flow in the river and direct it to the diversion structure.
- The diversion inlet is a gated concrete structure that controls the diversion of river water into the diversion channel during flood events. It is located at the entrance to the diversion channel on the north bank of the river.
- The service spillway is a gated concrete structure located in the river channel adjacent to the diversion inlet.
- The auxiliary spillway is dam safety component that is reserved to convey excess flood flow without overtopping failure of the dam or circumvention of the floodplain berm. The auxiliary spillway spans the 214 m between the floodplain berm and the service spillway.

4.1.2 Diversion Channel

The diversion channel carries floodwater from the diversion inlet into the off-stream reservoir. The channel is 4,700 m long with a bottom width of 22 m, 4H:1V side slopes and a slope that varies from 0.1% to 0.2%. At the design maximum flow in the diversion channel of 600 m^3/s, the required channel depth is 8.3 m, allowing for a maximum height of 6.4 m for floodwater and a minimum of 1.9 m of freeboard (room between the water and the top of the channel wall). The upper 700 m of the channel gradually flares out to a width of 150 m for delivery of water into the reservoir and is protected from head cut by riprap and a grade control structure where it enters the reservoir.

4.1.3 Emergency Spillway

The emergency spillway is a concrete structure approximately 135 m long that permits unregulated overflow, first to a graded channel and second, overland to Elbow River. The spillway has a crest at the reservoir full service elevation of 1,210.75 m asl and a discharge capacity (flow rate) of 354 m^3/s at 1.25 m of head. It is located on the east side of the diversion channel approximately 1,300 m before the off-stream reservoir, and it is designed to operate during a probable maximum flood when:

- the diversion inlet gates jam in the open position and cannot be closed
- the capacity of the reservoir is exhausted

The purpose of the emergency spillway is to prevent the retained water in the reservoir from overtopping the reservoir and, instead, release it in a controlled manner over the bedrock and return it to the river.

4.1.4 Off-Stream Reservoir and Dam

The off-stream reservoir uses existing topography to provide a basin within which diverted floodwater can be stored. Three floods are evaluated: a 1:10 year, 1:100 year and the 2013 flood. The Project has been designed to accommodate the 2013 flood, which had an estimated peak flow of 1,240 m^3/s and a 7-day volume of 149,600,000 m^3. Table 4-1 shows the reservoir retention volume, area flooded, and filling times for the three floods. Residence time and release time are based on modelling results. Actual residence time and release rates will vary depending on conditions downstream after the flood conditions in the river are past.

Table 4-1 Reservoir Volumes, Area and Floodwater Times

Flood Magnitude	Storage Volume Used (dam^3)	Area of Reservoir Flooded (ha)	Duration of Diversion (days)	Residence Time in Reservoir (days)	Release Time (days)
1:10 year	500	60	0.38	43	30
1:100 year	30,100	500	1.8	43	39
2013 flood	77,800	730	3.75	20	38

The off-stream dam is a clay-cored earth embankment that would temporarily impound diverted floodwaters. The dam would be constructed of material excavated from the diversion channel, supplemented if necessary, by borrow source material.

4.1.5 Outlet Structure and Low-Level Outlet

The outlet structure is a gated concrete structure near the east end of the dam embankment that controls release of retained water into the existing unnamed creek and back into Elbow River.

4.2 PROJECT PHASES

4.2.1 Construction

The Project is scheduled to be functionally operational (able to accommodate a 1:100-year flood event) after two years of construction and be completely constructed (able to accommodate the design flood) after three years of construction. Project construction may be continuous (24 hours per day), weather conditions permitting.

4.2.2 Dry Operations

Dry operation refers to Project operation between floods. During dry operation, the diversion inlet gates will close, and the service spillway gates will open. The outlet structure will remain open to carry the flow of the unnamed creek over which the dam will be built. The outlet gate system and its operation will be checked according to a routine maintenance schedule to be developed by AEP.

The associated access roads, emergency spillway and reservoir will be inspected at the same time and repaired, if necessary. The maintenance schedule will also include inspections of the diversion structure and the river channel upstream of it, the maintenance building, the floodplain berm, and the auxiliary spillway. Repairs and debris management will be completed, as necessary.

4.2.3 Flood Operations

AEP Operations will be in communication with the City of Calgary Glenmore Dam operators in advance of and during the flood season each year. The need for flood operations will be determined through this communication, which will be informed by forecasted and measured flows on Elbow River at the diversion structure and upstream. AEP Operations staff, in communication with the City of Calgary Glenmore dam operators, will decide on when to open the diversion gates to commence partial diversion of flood water flows in excess of 160 m^3 to the off-stream reservoir.

4.2.4 Post-Flood Operations

During post-flood operations, the diversion inlet gates are closed, and the service spillway gates are open (lowered to the river bed). The gates of the outlet structure will be opened to allow the floodwater retained in the reservoir to drain through the outlet structure into the unnamed creek and then into Elbow River. The outlet structure gates at the base of the reservoir will remain open after the reservoir has drained.

5.0 HYDROLOGY OVERVIEW

5.1 BASELINE CONDITIONS

Elbow River and its tributaries have a total watershed area of approximately 1,238 km^2. Elbow River transitions along its length between its headwaters and Glenmore Reservoir from a steep, generally single-thread channel mountain stream with pool-riffle sequences to a weakly braided/wandering pattern contained within a broad floodplain having lower gradients and typically poorly defined tributaries. The river is occasionally confined by limited bedrock canyons in the foothills and flows predominantly over gravel and cobble sized sediments for its entire length.

There are two Water Survey of Canada stations on Elbow River that provide long-term flow data: Elbow River at Bragg Creek (Station ID# 05BJ004), upstream of the PDA, and Elbow River at Sarcee Bridge (Station ID# 05BJ010), downstream of the PDA. Mean monthly flows for the period 1979 to 2014 for Bragg Creek and Sarcee Bridge showed distinct patterns that reflect their position in the Elbow River watershed.

At both stations, winter flows have been low in response to below freezing air temperatures and precipitation falling predominantly as snow. Spring flows increase first at Sarcee Bridge in March/April, which reflects local inputs of runoff over partially frozen ground with snow melt occurring at progressively higher elevations in the upper basin as spring progresses. Approximately 54% of the mean annual flow volume in the Elbow River watershed occurs during May, June and July. Of this percentage, 25% of the mean annual flow typically occurs in June alone. The higher variability evident in June reflects that this is the primary month for flood occurrence.

5.2 POTENTIAL PROJECT EFFECTS

The Project during flood and post-flood operations would affect hydrology surface water quantity and associated sediment transport in rivers, creeks and streams. These hydrological effects are intentional because the purpose of the Project is to mitigate floods, beginning with an approximate the 1:10 year flood (a peak flow of 200 m^3/s) up to the design flood (a peak flow of 1,170 m^3/s). This is achieved by maintaining a flow of 160 m^3/s in Elbow River.

The Project is designed to temporarily divert water (and associated suspended sediment) from Elbow River at flow rates above 160 m^3/s. As a result, significant modification of the Elbow River hydrology during a flood is the desired effect of the Project in order to protect Calgary (and farther downstream) infrastructure. The potential effects from the Project on hydrology are discussed in Volume 3A, Section 6.5 and Volume 3B, Section 6.4 of the EIA. The Project effects are summarized by Project phase, as follows.

Construction and Dry Operation

- Variations in hydrology and sediment transport are expected to be low and are likely not measurable within reasonable accuracy or detected by environmental receptors.
- Construction of the water diversion structure, dam and berm, and outlet structure will not affect hydrology in Elbow River.
- Construction activities may release suspended sediments and bedload sized material into Elbow River and the low-level outlet (unnamed creek). However, best management practices outlined in the contractors ECO Plan would mitigate this release.

Flood and Post Flood

- The Project is designed to divert flood flows as a mitigation for downstream flood damage. Therefore, changes to hydrology (i.e., mitigate peak flows and maintain a river discharge of 160 m^3/s) are considered positive. The change includes a decrease in the peak flow rate and volume in Elbow River.
- The modelling results suggest there will be a high magnitude effect on sediment yield during diversion and a temporary effect on suspended sediment concentration during release of water from the reservoir.
- During diversion, the Project would change aggradation and degradation of bed sediments resulting in a high magnitude effect on the morphology of Elbow River. During release of water from the reservoir, there would be a high magnitude effect on the unnamed creek.

6.0 WATER QUALITY OVERVIEW

6.1 BASELINE CONDITIONS

Water quality in Elbow River upstream of Glenmore Reservoir (referred to as upper Elbow River) is considered good for natural aquatic ecosystem processes and for human uses.

Suspended sediment concentrations in the upper Elbow River mainstem between Bragg Creek and Weaselhead Bridge were greatest during the summer season, lowest during the fall and winter, and intermediate in the spring (Volume 4, Appendix K, Section 3.2.1, page 3.2 of the EIA). The concentrations of suspended sediment increased from upstream to downstream. The increase in concentration from upstream to downstream was particularly distinct during the spring and summer. During fall and winter, this spatial pattern was less pronounced, but still present. Suspended sediment concentrations were lower at Glenmore Dam.

The upper Elbow River water temperature existing conditions data varied both seasonally and spatially, where temperatures were greatest during the summer, were lowest during the winter, and generally increased from upstream to downstream locations during all seasons. Water temperatures were higher during all seasons at Glenmore Dam compared to the upper Elbow River mainstem sites.

The upper Elbow River dissolved oxygen concentrations varied seasonally but were not associated with any apparent spatial pattern. Dissolved oxygen concentrations were greatest during the winter, lowest during the summer, and intermediate during the spring and fall. This seasonal pattern likely reflects the water saturation of dissolved oxygen, which decreases with increasing temperature.

6.2 POTENTIAL PROJECT EFFECTS

The Project is intended to reduce Elbow River flood water flow by retention of water temporarily in an off-stream reservoir. This means that, by design, the Project affects flows in Elbow River and flow mainly determines suspended sediment concentration. The complex dynamics between flow and sediment movement during floods in Elbow River are assessed in Volume 3B, Section 6 of the EIA. Water temperature, dissolved oxygen, and metal methylation conditions change similarly in response to the diversion of flood water and retention in the reservoir prior to release back into Elbow River.

Project-related effects from water quality will be monitored by collecting water samples in the off-stream reservoir just prior to and during release of water from the reservoir. Monitoring results will be used to inform downstream water users and assist their water use and treatment decisions. The potential effects from the Project on water quality are discussed in Volume 3A,

Section 7.4 and Volume 3B, Section 7.4. The Project effects are summarized by Project phase below.

Construction and Dry Operation

- Construction and maintenance activities have the potential to disturb soil and instream bed substrates causing erosion and suspended runoff, and release of instream sediments.
- Herbicides will be applied to control weeds near the Project infrastructure; however, effects from herbicide use on water quality will not be significant and will be mitigated through the use of the Code of Practice (GoA 2010) and the low frequency of herbicide use by the Project.

Flood and Post Flood Operations

- The effects 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.
- Suspended sediments are predicted to increase at the end of the off-stream reservoir drawdown period and result in increased suspended sediments and suspended sediment related parameters in Elbow River.
- The estimated low and high methylmercury concentrations generated from bacterial activity in newly inundated soils (in the off-stream reservoir) is predicted to generally be below the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guideline for the Protection of Aquatic Life (CCME 1999; 0.004 µg/L). However, predicted high methylmercury concentrations for 1:10 and 1:100 year floods may reach levels above the Environmental Quality Guidelines for Alberta Surface Waters in the off-stream reservoir (GOA 2018; 0.001 µg/L [long term] and 0.002 µg/L [short term]).

7.0 AQUATIC ECOLOGY OVERVIEW

7.1 BASELINE CONDITIONS

Elbow River transitions between the headwaters and the Glenmore Reservoir from a steep, generally single channel mountain stream with pool-riffle sequences to a weakly braided/wandering pattern contained within broad floodplain with low gradients and typically poorly defined tributaries. Fish habitat in Elbow River is rated as primarily good run habitats, interspersed with riffle and pool habitats. Overhead cover is related to undercut banks and overhanging vegetation. Instream cover is mostly woody debris and large sized substrate (boulder/cobble). Substrate composition throughout Elbow River consists of cobble and pebble, with smaller amounts of gravels and sand. Within the aquatic LAA, spawning, overwintering, and rearing habitats are rated as "moderate-good" to "good" habitat for forage, coarse, and sport fish.

Fish species distribution in the aquatic LAA reflects the change in channel size, substrates, and gradient as the river habitats change from steep, higher elevation, and erosional channels to lower elevation depositional channels. Elbow River contains a variety of fish species including brook trout, brown trout, bull trout, burbot, cutthroat trout, mountain whitefish, rainbow trout, white sucker, longnose sucker, and mountain sucker.

Elbow River supports a recreational fishery that has been a part of known local and national fishing culture from the early 1990s, with the Glenmore Reservoir being a popular sport fishing location for northern pike, trout, and perch. Salmonids are the most abundant fish species caught in Elbow River, with brown trout being the most abundant salmonid in the lower section and bull trout being the most abundant in the sections from the project site to Elbow Falls, and above Elbow Falls. Brook trout and rainbow trout are found consistently throughout the three river segments. There are no known commercial fisheries on Elbow River, nor are there commercial fishing licenses on any lakes within the aquatic LAA or RAA.

7.2 POTENTIAL PROJECT EFFECTS

The Project (i.e., during flood and post-flood operation) is designed to intentionally affect stream flows to mitigate the effects of floods in Elbow River. During flood conditions, Elbow River flows will be maintained at 160 m^3/s and partial diversion of flood waters into the reservoir will occur at Elbow River flows between 160 m^3/s and 1,170 m^3/s. The construction of the diversion inlet and spillway, and the operation and post-flood operations will result in changes to the flow regime, water quality, and fish habitat in the river. The potential effects from the Project on fish and fish habitat are discussed in Volume 3A, Section 8.4 and Volume 3B, Section 8.2 of the EIA. The Project effects are summarized by Project phase below.

Construction and Dry Operations

Permanent alteration of fish habitat:

- Approximately 1,854 m^2 of Class 2 and Class 3 run fish habitat types from the footprint of the service spillway and gate will be permanently altered.
- Approximately 2,696 m^2 of rapid and Class 2 and Class 3 run fish habitat types from temporary work areas between the gate and diversion channel will be temporarily altered.
- Relevant monitoring requirements will be detailed in the offset plan and will inform an updated Surface Water Monitoring Plan.

Destruction of fish habitat:

- Approximately 1,200 m of stream length of a tributary (I.D. 1350) would be cut off by the diversion channel, although only the lowest 300 m is potential fish habitat.
- The residual effects on change in habitat, movement, and mortality risk are unlikely to pose a long-term threat to the persistence or viability of a fish species.

Flood and Post Flood Operations

Permanent alteration of fish habitat:

- Natural channel planform and bedload movement is predicted to be maintained during flood and post-flood operations. However, the magnitude of aggradation and degradation of bed sediments on bar heads during diverted floods is predicted to decrease slightly (i.e., less than 0.2 m for 99% of bar head areas).
- Increased turbidity and the deposition of sediment on substrates could affect the quality of fish habitat in the unnamed creek and in Elbow River downstream of the its confluence with the unnamed creek. Turbidity will be monitored in Elbow River and the unnamed creek during water release from the off-stream reservoir.

Fish mortality:

- Entrainment of fish into the off-stream reservoir during active diversion may cause bodily harm to fish as they are transported along the diversion channel.
- Fish may be stranded during water release from the off-stream reservoir, resulting in fish stress or mortality. A qualified aquatic environmental specialist (QAES) will be onsite to monitor site conditions and implement the fish rescue program.

8.0 MITIGATION

Environmental protection and measures to mitigate effects on hydrology, water quality and aquatic ecology for construction and operation of the Project have been developed based on best management practices described in the Fish Habitat Manual (Alberta Transportation 2001), the COP for Watercourse Crossings (ESRD 2013), and DFO's Measures to Avoid Causing Harm to Fish and Fish Habitat (DFO 2013a). Construction contractors will also implement relevant mitigations through Alberta Transportation's Environmental Construction Operations (ECO) Plan process. The mitigation measures are presented in terms of project related activities (i.e., phases) and are relevant to each of hydrology, water quality and aquatic ecology (Table 8-1).

Table 8-1 Surface Water Mitigation Measures

Mitigation	Project Mitigation Details	Project Phase
Construction Timing	• Works in water and instream activities will be timed with respect to the restricted activity periods (RAPs) wherever possible. For Elbow River, the RAP is May 01 – July 15 and September 16 – April 15. • Condition and use of restricted activity periods will be provided within further project permitting and authorization under the Fisheries Act.	Construction
Instream Construction	• All applicable regulatory notifications, permits, and authorizations including the Environmental Protection and Enhancement Act, Water Act and the federal Fisheries Act and Navigable Waters Protection Act, will be obtained before the start of any instream construction. • Information collected during instream construction monitoring and site inspection observations will be used to adaptively manage construction and site activities. Appropriate mitigations and response actions will be used to control site conditions to manage environmental compliance issues such as erosion and sediment runoff.	Construction
Erosion and Sediment Control	A site-specific Erosion and Sediment Control Plan will be developed by the selected construction contractor as part of the project-specific ECO Plan, and implemented during the various phases of construction and should include site-specific mitigation measures to suit the site and finalized design and construction plans. The plan would include, but not be limited to, the following practices where applicable: • Instream work areas will be isolated from the main river flow by using cofferdams, silt fences and turbidity barriers. TSS will be monitored and measured in conformance with Alberta Transportation's Turbidity and Monitoring specifications. • Silt fences, turbidity barriers and riprap materials will be used to prevent future bank erosion. • Erosion and sediment control measures will be installed before starting work to prevent sediment from entering the water body. • Erosion and sediment control measures will be regularly inspected daily and maintained during construction. • Erosion and sediment control measures will be repaired immediately if damage occurs. • Non-biodegradable erosion and sediment control materials will be removed once the site is stabilized. • Sediment and erosion control devices will be constructed to withstand anticipated flows during construction. If necessary, the outside face of granular berms may be lined with heavy poly-plastic to make them impermeable to water. • Excavated materials and debris will be stockpiled above the highwater mark and in such a way as they do not enter the watercourse. Silt fences will be used to contain soil erosion.	Construction, Dry Operations (maintenance and cleaning)

Table 8-1 Surface Water Mitigation Measures

Mitigation	Project Mitigation Details	Project Phase
Erosion and Sediment Control (cont'd)	• Isolation materials will be designed to reduce disturbance of the bed and banks of Elbow River and other watercourses. • Clearing of riparian vegetation will be kept to a minimum. Bank and riparian areas disturbed during construction will be reclaimed and re-vegetated. • Weeds will be controlled during construction through multiple measures, such as herbicide, mowing, wicking, and hand picking. After construction, disturbed areas will be stabilized and reclaimed. • Erosion and sediment control measures will be monitored until vegetation has become sufficiently reestablished.	Construction, Dry Operations (maintenance and cleaning)
Water Management during Construction	• Flows in Elbow River will be maintained downstream of the Project (e.g., bypass channel). • Measures for managing water flowing onto the site, as well as water being pumped/diverted from the site will be implemented such that sediment is filtered out before the water enters a waterbody (e.g., silt fences, turbidity barriers, pumping/diverting water to a vegetated area, constructing a settling basin, or other filtration system). • Sediment laden dewatering discharge will be pumped into a vegetated area or settling basin to allow sediment to settle out before returning it to the water body. Silt fences, turbidity barriers and clean granular berms will be used to contain the sediment and other deleterious substances and to prevent it from entering a watercourse or water body. • Energy dissipaters will be used at pump outlets to prevent erosion.	Construction
Reclamation	• The top substrate from a wetted channel will be stripped and stockpiled for later use as the top layer of reclaimed instream substrate to improve the recolonization rate of sediment flora and fauna (e.g., seed-bank and invertebrate cycts) and maintain average mobile substrate sizes. • Rootwads and large boulders that have to been removed will be stored on-site for subsequent placement on reclaimed instream cover or for bank protection. • Fertilization of reclaimed areas in the immediate vicinity of a watercourse will not be allowed unless approved by DFO and AEP. • Streambanks and approach slopes will be revegetated using an appropriate native seed mix or erosion control mix.	Construction

Table 8-1 Surface Water Mitigation Measures

Mitigation	Project Mitigation Details	Project Phase
Fish Passage	• Boulders will be added to increase the bed roughness of the river channel immediately downstream of the diversion structure, which will increase water depths and reduce velocities. • Boulder V-weir structures will be constructed in the river channel downstream of the gates to provide slower velocity and deeper resting zones. • A monitoring plan will be undertaken to identify if fish passage is impeded for migratory salmonids or other fish species. • To maintain upstream fish passage in Elbow River after a flood has occurred, debris will be cleaned from the structure gates after a flood recedes to allow unimpeded fish passage upstream over the structure. Maintenance, debris removal on the structure, and on the fish passage structures will occur immediately to accommodate fish passage.	Construction, Dry Operations (maintenance and cleaning)
Managing Contaminants	Potential contaminant-related effects will be mitigated through Project design (e.g., road water runoff management), implementing a spill containment and response plan, using appropriate sediment and erosion control measures, limiting the use of and following best management practices for herbicides and fertilizers in the dry reservoir or near waterbodies, and using nontoxic biodegradable hydraulic fluids in equipment for any required instream works. Activities near water will be planned and completed in the dry and isolated from watercourses to prevent materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, other chemicals or other deleterious materials from entering the watercourse. Structures will be designed so that storm water runoff and wash water from the access roads, decks, side slopes, and approaches will be directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity, and prevent sediment and other deleterious substances from entering the watercourse. Other substances will be controlled on the construction site through: • Transport of hazardous materials to and from the Project site, storage, use and disposal will be in accordance with regulatory requirements. • Construction equipment will be mechanically sound with no oil leaks, fuel or fluid leaks. Equipment will be inspected daily, and any leaks will be immediately repaired. • Persons qualified to handle construction equipment fuels and lubricants will perform repairs. • Service vehicles will carry fuel spill clean-up materials.	All Phases

Table 8-1 Surface Water Mitigation Measures

Mitigation	Project Mitigation Details	Project Phase
Managing Contaminants (cont'd)	• Containment berms and impermeable liners will be used around fuel and lubricant storage tanks. • A minimum 100 m setback will be maintained between stored fuels and lubricants and rivers, streams and surface water bodies. • Building material used in watercourses, including concrete, will be handled and treated in a manner that prevents the release or leaching of substances that may be deleterious to fish into the water. • Activities near water will be planned and completed in the dry and isolated from watercourses to prevent materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, other chemicals or other deleterious materials do not enter the watercourse.	All Phases
Herbicide Management	Herbicides would be applied according to Environmental Code of Practice for Pesticides (GoA 2010) and: • restrict herbicide mixing and loading within 30 m of an open body of water. • identify open bodies of water within the application sites. • mark or flag of open bodies of water that will not be clearly visible to the applicator. The Code of Practice specifies minimum distances that need to be maintained from open bodies of water, depending on the type of herbicide used.	Construction, Dry Operations
Debris Management	• Debris will be removed from the structure and gates prior to spring freshet annually in May or June, to ensure the structure is operating properly when river flow increases and the likelihood of flooding is highest. • Where debris removal on the structure is required, debris removal will be timed to avoid disruption to sensitive fish life stages (i.e., outside the RAP), unless the debris and sediment accumulation interferes with the flow of water into and out of the reservoir (for future floods) or is a risk to the integrity of the structure or relates to an emergency (i.e., risk of structure failure). • Large woody debris taken from the structure and gates will be removed from the beds and shores of Elbow River.	Dry Operations (maintenance and cleaning)

Table 8-1 Surface Water Mitigation Measures

Mitigation	Project Mitigation Details	Project Phase
Outflow Control	• The off-stream reservoir will be slowly drained to facilitate the movement of fish from the reservoir, into the unnamed creek, back into Elbow River with the receding water. • The low-level outlet will be designed and operated in a manner that allows fish egress out of the reservoir, into the unnamed creek, and then into Elbow River. • Drainage areas within the off-stream reservoir will be graded to provide positive drainage and reduce stranding of fish during release of water from the reservoir • During draining of the off-stream reservoir, monitoring will be undertaken to identify isolated pools and the potential that fish may become stranded. If potential fish stranding is identified, further action will be taken to reduce the potential mortality of fish.	Post-Flood

9.0 MONITORING

This section provides an overview of monitoring activities as they pertain to each phase of the Project and will inform how the project adaptively manages and operates during the following phases:

- Construction
- Compliance Monitoring
- Operational Monitoring – Dry Operations
- Operational Monitoring – Flooding
- Operational Monitoring – Post-flooding.

Regulatory conditions applied to approvals and authorizations, and the completed ECO Plan will provide additional specific monitoring details used to update this plan.

9.1 CONSTRUCTION MONITORING

Construction monitoring includes monitoring surface water during construction within Elbow River and the low-level outlet tributary if water is present. The following subsections include monitoring criteria and instructions from Alberta Transportation's (2017) "Special Provision – Turbidity" and from the Government of Alberta's (2005) "A Guide to Release Reporting."

Alberta Transportation has an environmental management system (EMS) that will be applied to the Project. The EMS identifies environmental monitoring as an important component of Project activity and requires an environmental protection plan to be developed by the selected construction contractor using Alberta Transportation's ECO Plan framework.

The ECO Plan is a project-specific plan that identifies and mitigates the potential environmental effects of construction, which will include relevant mitigation measures detailed in the EIA and listed in Table 8-1, and Alberta Transportation's *Civil Works Master Specifications for Construction of Provincial Water Management Projects*. The selected construction contractor will be responsible for preparing the ECO Plan specific to the work and the Project site. Alberta Transportation and the contractor will review the ECO Plan before construction begins. The selected construction contractor will ensure the effective implementation of the ECO Plan, including the relevant mitigation measures listed Section 8.

Increased suspended solids naturally occur in all waterbodies at different times of the year. During precipitation events, runoff will erode exposed soils and transport soil particles as suspended sediments. Internal watercourse processes will cause streambed substrates to mobilize, which will cause suspended sediment. Erosion and suspended sediments can increase in modified environments where the stream flow regime is altered or surface terrains are modified. Areas such as construction sites where soils are exposed and disturbed are vulnerable to erosion and sediment runoff.

At the beginning of construction, monitoring crews will meet with the Alberta Transportation site representative and the construction supervisor. Monitoring and inspection expectations will be agreed upon including:

- site safety and check in requirements
- chain of communication
- review recommendations and project requirements stipulated in the qualified aquatic environmental specialist (QAES) report and relevant regulatory approvals (e.g., the Alberta *Water Act* approval and the *Fisheries Act* authorization)
- monitoring frequency
- contingency planning and mitigation implementation
- reporting criteria (i.e., in the event of a water monitoring exceedance or visual plume is observed, who is responsible for reporting to the regulator)

9.1.1 Suspended Solids Monitoring

All contractors, construction personal and others working in and around water must comply with regulatory standards that prevent suspended solids from entering a waterbody. Alberta Transportation (2011, 2017) outlines how suspended solids and turbidity will be monitored and mitigated during construction. Total suspended solids (TSS) includes suspended sediments. The terms suspended solids and suspended sediments are.

The objective of monitoring suspended solids during construction activities is to determine if sediment mitigation measures and erosion and sediment controls are effective. The monitoring results will be used to inform and adaptively manage construction activities to minimize construction related suspended sediments in Elbow River. The draft monitoring Plan will be modified as needed in the field to compliment the construction activities as they are developing; however, the main points for the program are outlined as follows.

9.1.1.1 Sampling Points – Transects

The sampling design must consider site specific waterbody characteristics including stream size and width, water depth, water velocity and flow (i.e., laminar flow vs turbulent flow).

Monitoring transects will be established where background and downstream water samples will be collected in a manner that captures changes is suspended sediment concentrations near the construction site. Based on Alberta Transportation (2017) transects will be places as follows:

- background transect: upstream of work area
- Transect 1: 30 m downstream from work area

- Transect 2: 60 m downstream from work area
- Transect 3: 90 m downstream from work area

Sampling points will be 25%, 50% and 75% of wetted with at each transect.

Where a visual plume is observed, a sample must be taken from the middle of the plume and as close to the source as safely possible.

Water samples will be at 50% water depth where water is less than 1 m deep. Where watercourses are greater than 1 m deep, samples will be taken at 20% and 80% of water depth at each transect sample point and results averaged.

9.1.1.2 Sampling Frequency

Daily sampling shall occur from 30 minutes prior and 30 minutes after construction activities.

During periods of instream construction activity, the minimum sampling frequency will be once every hourly at all transects.

When construction activities are within isolated conditions, samples will be collected at all transects at three-hour intervals during.

Where samples have not exceeded background levels greater than 5 mg/L for five consecutive days with continuous active construction, sampling frequency may be reduced to a minimum of twice per day.

When a plume is detected, or water quality does not meet compliance criteria, monitoring will be done at all transects and within the plume sampling point as often as feasible (i.e., an hourly basis at a minimum). Monitoring will continue until two consecutive monitoring events show TSS levels have returned to acceptable background levels and there are no compliance exceedances.

During accidental occurrences, sampling will not proceed until it is safe to do so.

9.1.1.3 Suspended Sediments – Turbidity Relationship

Total suspended solids are measured in the field indirectly by measuring Nephelometric Turbidity Units (NTU) as a surrogate for sediment. Rather than collecting samples for TSS analysis, samples are collected for measuring NTUs using a turbidity meter in the field. The relationship between turbidity and suspended sediments will be established prior to monitoring; this relationship will be used to infer suspended sediment concentrations from turbidity results.

Specific details to develop a turbidity curve to establish the site-specific relationship between TSS and NTU is provided in Alberta Transportation's "Conversion Relationship Between Nephelometric Turbidity Units (NTU) into mg/L for Alberta Transportations' Turbidity Specification" (Alberta Transportation, [No Date]). The steps to establish the turbidity curve require site samples being sent to a certified lab for TSS analysis; therefore, the turbidity curve will be established prior to construction commencing.

9.1.1.4 Compliance Criteria

Compliance criteria for construction TSS monitoring are outlined as follows in Table 9-1 (Alberta Transportation 2017; GoA 2018; CCME 2002, 2018):

Table 9-1 Maximum Allowable Increase of Total Suspended Solids

Site Conditions (Background TSS)	Exceedance Levels (TSS in Excess of Normal Background Levels)
TSS < 25 mg/L	• A maximum instantaneous increase of 25 mg/L over background levels at any time. • An average increase of >5 mg/L over background levels for greater than 24 hours.
TSS 25 mg/L – 250 mg/L	• A maximum instantaneous increase of 25 mg/L from background levels at any time.
TSS > 250 mg/L	• Maximum instantaneous increases of 10% of background levels at any time.

The arithmetic mean TSS concentration (mg/L) will be calculated for each background sampling event. The arithmetic mean TSS concentration will be calculated for each monitoring transect and compared with the mean background TSS concentration. If the results for any monitoring transect exceed the limits in Table 9-1, the construction activities are not in compliance.

9.1.1.5 Record Keeping

Daily TSS compliance monitoring records will be kept and maintained during construction and will be available on site.

9.1.2 Fish Management, Fish Salvage Monitoring

Site habitat sensitivities and resident fish population requirements will be considered when conducting instream construction activities. Monitoring recommendations will be incorporated into the site monitoring plan.

Elbow River is a Class C River with a restricted activity period (RAP) from May 1 to July 15 and September 16 to April 15. Instream activities that occur within the RAP and outside the periods that are considered the least biologically sensitive (e.g., periods of time when spawning or

migration may be occurring) may require extra monitoring and attention to prevent serious harm to fish.

Before instream construction commences, a fisheries biologist will survey the instream construction area and ensure site conditions are consistent with information provided to obtain any approval and authorizations.

Site mitigation measures intended to prevent serious harm to fish and ensure compliance with approvals and authorizations will be routinely inspected to confirm mitigations are installed appropriately and functioning as intended.

Where enclosures or isolations are installed, a fisheries biologist will monitor dewatering operations to ensure any fish missed during the fish salvage are captured and relocated outside the isolation.

The provincial fish research permit (FRL) authorizing a fish salvage will be reviewed prior to any fish salvage activities occurring. Monitoring conditions outlined in the FRL will be performed to ensure the wellbeing of any fish captured and salvaged on site. This will include conditions salvaged fish are temporarily kept in after capture and prior to release and will include fish heath.

During dewatering, water pumps will be monitored for impingement of fish on intake screens.

9.1.3 Post-Construction Habitat Restoration

At the end of construction, fish habitat in Elbow River will be restored in a manner that reflects existing habitat in Elbow River and as directed in any approvals and authorizations. Site monitoring during post-construction habitat restoration activities will consistent with construction monitoring. This includes monitoring erosion and sediment where relevant (i.e., instream or when activities may directly or indirectly contribute to instream sediments).

Habitat restoration monitoring will include reclamation of disturbed construction site areas and assessing how land cover returns to their intended use. This includes the effectiveness of post-construction sediment and erosion controls and vegetation re-growth along banks and slopes that convey overland runoff to waterbodies including Elbow River.

Fish habitat will be inspected and assessed “as built” and any deficiencies in the restored habitat will be described.

Approvals and authorizations for restored habitat may require annual monitoring to:

- determine that restored habitat withstands environmental and seasonal hydrologic changes

- determine the extent resident fish use restored habitat
- assess the relevant "habitat value" of restored habitat and its contribution to resident Elbow River fish

9.1.4 Indigenous Monitoring

During construction, Indigenous environmental monitors may provide assistance with onsite construction monitoring activities. Environmental monitors whom are properly trained and experienced in safety protocols regarding working in and around water (e.g., swift water training) as well as environmental monitoring techniques can participate in the following activities:

- assist with QAES to establish site monitoring locations and transects
- collect surface water samples for turbidity measurements
- conduct fish salvage activities including fish netting, safe fish handling, and monitoring fish condition and health during salvage activities
- complete data recording.

9.1.5 Reporting Requirements

9.1.5.1 Construction Monitoring

Information to be documented during construction includes:

- written and photo-documented sequence of events during construction
- changes to design and field-fitting to adapt to unanticipated field conditions (will be further discussed with DFO if important changes are observed)
- technical issues that arise and how they are addressed
- confirmation that offsetting components meet the design requirements, and
- confirmation that the terms of the AEP *Water Act* Approval and DFO *Fisheries Act* Authorization are met.

A weekly summary report will be produced with the following:

- brief description of the works and types of construction activities completed during the sampling period
- date and time of each sample
- weather conditions at the time of each sample
- changes of depth of flow at the upstream transect

- documentation of daily NTU instrument calibrations
- turbidity (NTU) and TSS (mg/L) for each sample taken
- daily average value (mg/L TSS) of the upstream background samples
- daily average value (mg/L TSS) for each downstream transect (all three sites per transect combined)
- documentation of all non-compliance instances, including the level of exceedance, the duration of exceedance, the mitigation measures taken, verification of the reporting of the exceedance and any related communications with regulators regarding the exceedance event, and future measures to be taken to avoid or control further exceedances.
- description of events or circumstances that may have prevented or hindered completion of the TSS monitoring Plan

Upon completion of construction activities, a final construction monitoring report with all sampling and testing data will be produced.

If a TSS sample exceeds compliance criteria or a plume of sediment is observed, all work that may result in an impact (directly or indirectly) shall be stopped and mitigations put in place. The Environmental Response Hotline shall be called at 1-800-222-6514. A written report must be submitted within seven days of the initial report and submitted to:

Alberta Environment Environmental Response Centre
111 Twin Atria Building
4999 – 98 Avenue
Edmonton, AB T6B 2X3

or faxed to (780) 427-3178

Written reports will include:

- the date and time of the release
- the location of the release
- the duration of the release and the release rate
- the composition of the release for each substance, including:
  - concentration
  - total weight, quantity or amount released
- a detailed description of the circumstances leading up to the release
- the steps or procedures which were taken to minimize, control or stop the release
- the steps or procedures which will be taken to prevent similar releases
- any other information required by the Director

9.1.5.2 Fish Management and Fish Salvage Monitoring

Reporting for fish rescue activities will include a fisheries loadform that will be submitted to AEP according the conditions in the FRL; this is considered the fish salvage report. Information to be submitted in the loadform includes a minimum of the following for each fish unless otherwise specified in the FRL:

- reasons for fish capture
- habitat type
- fish capture location and time
- fish species
- fork length
- weight
- sex (if know)
- age or life stage

9.1.5.3 Habitat Restoration

A fish habitat assessment report with associated habitat mapping will be generated to satisfy approvals and authorizations for habitat restoration and enhancements. Any activities used to mitigate construction or instream work as they pertain to fish habitat will be included in the final report.

Reporting will include:

- surveyed mapping of as built restored fish habitat
- photo documentation of Elbow River habitat and restored habitat elements
- stream flows and velocities
- insitu water quality (i.e., temperature, dissolved oxygen, pH, conductance and turbidity)
- habitat assessment to determine potential habitat value of restored habitat elements with existing habitat
- assessment of potential habitat impacts that occur due to the Project

9.2 COMPLIANCE MONITORING

An Alberta *Water Act* approval and *Fisheries Act* authorization will be required to construct project related facilities within the beds and shores of Elbow River and the outlet tributary. Approvals and authorizations will also cover water diversions and possible fish entrainment into the off-stream reservoir. These will require monitoring as per *Fisheries Act* provisions related to alteration and destruction of fish habitat, and serious harm to fish. Additionally, monitoring will be required to meet the provisions for stream flows and fish passage. A summary of relevant monitoring for fish passage and a habitat offset is provided here; details will be updated through discussions with AEP and DFO.

9.2.1 Fish Passage

The limiting factor with the Project for fish passage is the combination of low water levels and high flow velocities through the service spillway and stilling basin and in the Elbow River channel immediately downstream of the spillway. To manage stream depths downstream of the spillway, rock v-weirs will be installed at three gradient changes (i.e., steps) to converge stream flows to the middle of the river channel in a manner that increases water depth. Each v-weir will provide flow conveyance and fish passage between gradient changes from downstream to upstream.

The minimum governing criteria for depth and flow calculated to maintain serviceability and fish passage through the instream works of the Project requires a depth of 18 cm and a calculated river low-flow of 0.8 m^3/s. Fish considered for these passage criteria include anguilliform and trout species.

Fish passage monitoring to comply with approvals and authorizations will include surveying flow velocities and water depths within the crest of the service spillway, the stilling basin and each rock v-weir during low flows to ensure the structures as built structures meet the conditions for fish passage. Monitoring surveys will be conducted late in the summer during baseflow conditions the year after construction.

A staff gauge with cm increments below 50 cm will be installed on the side of the spillway for ongoing water depth monitoring by operations staff. Regular water depth observations will be made and recorded for due diligence purposes.

9.2.2 Offset Monitoring

A federal *Fisheries Act* authorization will be required to alter or destroy habitat that results in serious harm to fish. This will necessitate an offsetting plan that compensates lost habitat and maintains the sustainability and ongoing productivity of resident commercial, recreational or aboriginal fisheries.

The Project will result in approximately 4,550 m^2 of altered habitat on the beds and shores of Elbow River at the planned gate structures and tailrace, including 1,854 m^2 permanent alteration of Class 2 and Class 3 run fish habitat types from the footprint of the gate. There will be temporary habitat alteration of 2,696 m^2 of rapid and Class 2 and Class 3 run fish habitat types from temporary work areas between the gate and diversion channel.

The offsetting plan and supporting monitoring Plan will be developed through consultations with DFO. The objective of the monitoring will be to assess the effectiveness of proposed offsetting measures in compensating serious harm to fish. A *Fisheries Act* authorization will include monitoring and reporting conditions (DFO 2013b).

9.2.3 Reporting Requirements

Flow rate measurements within the service spillway will be regularly observed and recorded for due diligence purposes.

A post-construction report will be provided to DFO at the completion of construction, which will outline the as-built condition of the offsetting measures. In addition to a photographic log, as-built engineer drawings, and construction monitoring, post-construction measurements may include:

- location and measurements of the structures on the beds and shores
- location and quantity of the vegetation reclamation
- location and measurements of the fish passage engineered mitigation structures
- fish habitat, abundance, distribution, and benthic invertebrate monitoring in previously sampled reaches (Reach 1 through Reach 12)
- location and measurements of required fisheries offsetting measures

An annual offset monitoring plan will be produced and submitted to DFO as per the *Fisheries Act* Authorization Schedule.

9.3 OPERATIONAL MONITORING – DRY OPERATIONS

Operational monitoring includes environmental components that may be directly or indirectly affected by, or will affect, Project operations.

9.3.1 Elbow River Stream Flows

Elbow River flow rate will be monitored at the spillway where a pressure transducer and staff gauge will be installed. The river flow rate has a linear relationship with water depth within the cross section of the service spillway opening, which will allow operations staff to routinely monitor flows and prepare to engage the diversion inlet. Continuous data from the pressure transducer will be provided to the operator by telemetry. Routine staff gauge observations will be made during low flow periods (i.e., late summer base flow) and observations will be recorded for due diligence purposes.

AEP has existing continuous long-term hydrology monitoring stations at Bragg Creek (05BJ004; hourly and 15-minute flow/stage data) and Sarcee Bridge (05BJ010; hourly flow/stage data) in Calgary. This data is available electronically in “real time” for Project staff to use for operational management purposes.

9.3.2 Suspended Sediments During Cleanup and Maintenance

Regular maintenance and annual cleanup activities will include moving large woody debris and sediment from around the diversion structure and service spillway. These activities have the potential to generate suspended sediments within the river. Instream suspended sediment monitoring will be done as outlined in Section 9.1.1.

Monitoring associated with maintenance and clean-up activities in the diversion channel and reservoir will occur under dry conditions and are not covered under this monitoring plan.

9.3.3 Indigenous Monitoring

During dry operations (between floods), Indigenous environmental monitors may provide assistance with onsite monitoring activities. Environmental monitors whom are properly trained and experienced in safety protocols regarding working in and around water (e.g., swift water training) as well as environmental monitoring techniques can participate in the following activities:

- assist QAES to establish site monitoring locations and transects.
- collect surface water samples for turbidity measurements.
- complete data recording.

9.3.4 Reporting Requirements

9.3.4.1 Elbow River Flows

Elbow River flows will be monitored in conjunction with AEP's Environmental Monitoring Plan and River Monitoring Network. Hydrometric data will be recorded as per AEP protocols. No additional reporting for Elbow River flows is required

9.3.4.2 Suspended Sediments During Clean-up and Maintenance

Reporting requirements for monitoring suspended sediments during clean-up and maintenance activities are outlined above in Section 9.2.1.

9.4 OPERATIONAL MONITORING – FLOOD OPERATIONS

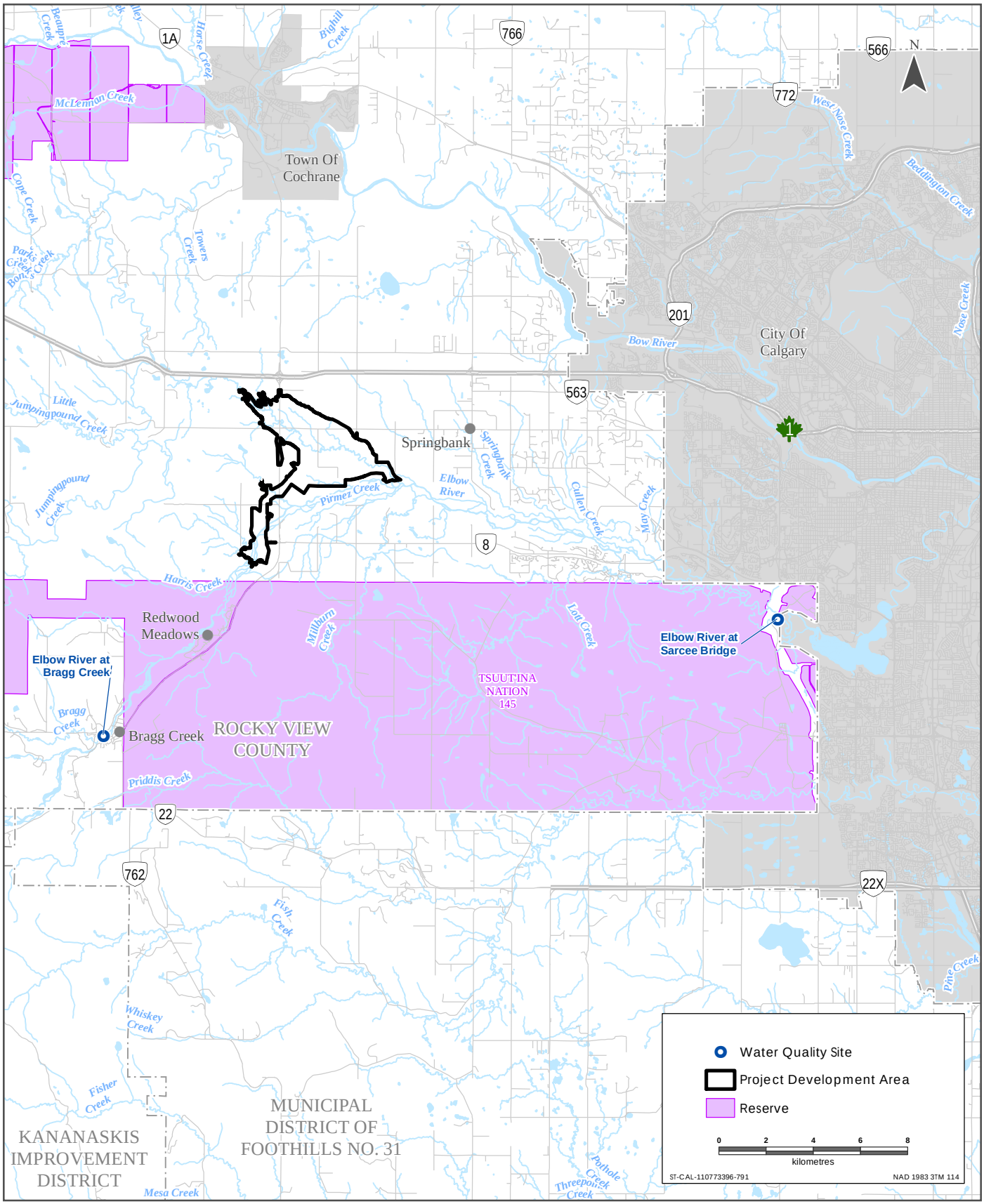
9.4.1 Elbow River Stream Flows

Elbow River stream flow monitoring will be done to measure and monitor river discharge, and to manage the diversion intake (Figure 9-1 and Figure 9-2). The service spillway will be initiated and a portion of Elbow River flood flows will be diverted through the diversion structure, when river flow rate reaches 160 m^3/s. (the diversion inlet is designed to accept up to 600 m^3/s).

A transducer will be installed in the diversion channel to monitor diversion rates and flows into the off-stream reservoir. A secondary monitoring location in the diversion channel will be used as a backup to maintain a diversion rate below 600 m^3/s.

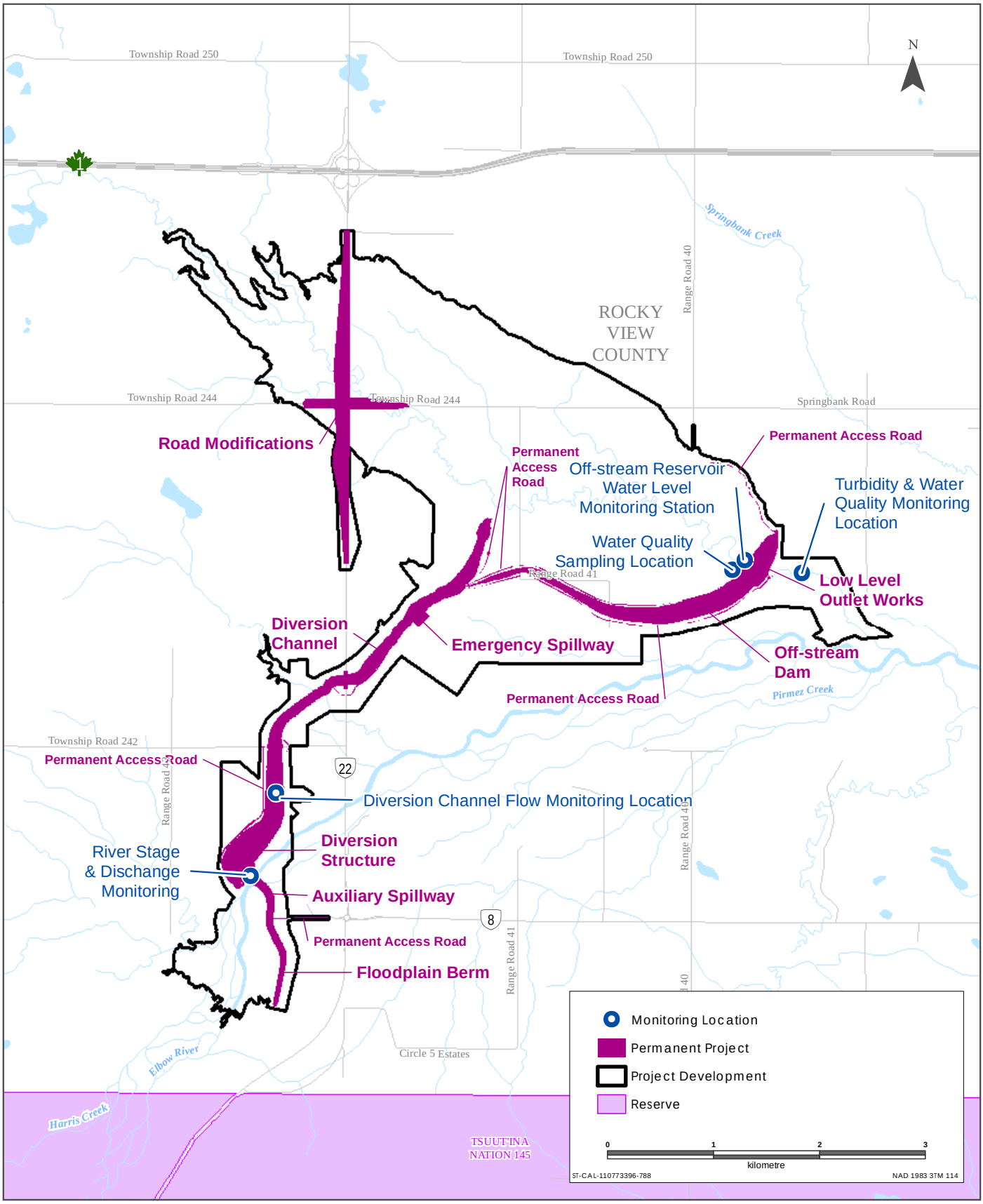
River flow will be monitored in conjunction with reservoir depth and volume to manage downstream flows. If the reservoir reaches its full service level, the diversion structure will be closed, and Elbow River flows will not be diverted and the water will continue downstream.

Elbow River flows will be monitored as discussed in Section 9.3.1.



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Canada, Government of Alberta, Stantec Ltd

Alberta Environment and Parks Long Term Elbow River Monitoring Stations



Sources: Base Data - ESRI, Natural Earth, Government of Alberta, Government of Canada
Thematic Data - ERBC, Government of Alberta, Stantec Ltd

Proposed Water Quality Sampling, Reservoir Level Monitoring, and Turbidity Monitoring Locations

Stantec

9.4.2 Reservoir Depth/Volume

The off-stream reservoir water depth will be monitored as the reservoir is filled to track the reservoir's available volume and holding capacity. This will permit staff to manage water entering the off-stream reservoir.

The relationship between the off-stream reservoir volume and depth is known; therefore, water depth will be monitored to determine available reservoir volume. A monitoring station will be located near the off-stream reservoir outlet gates on the reservoir berm. The monitoring station will include two monitoring components. First, a permanent marker (i.e., staff gauge) will be installed on the reservoir berm near the outlet gate to indicate when water levels are reaching the maximum reservoir capacity. Second, a pressure transducer with remote telemetry will be installed on the berm near the outlet gate for continuous monitoring by the reservoir operator (Figure 9-2).

9.4.3 Reporting Requirements

9.4.3.1 Elbow River Stream Flows

Elbow River diversion rates and flow rates will be documented and reported to the City of Calgary and Glenmore Reservoir operator to assist in downstream reservoir management.

9.5 OPERATIONAL MONITORING – POST-FLOOD OPERATIONS

9.5.1 Elbow River Flows

Hydrology monitoring will be done on Elbow River to determine when to release water from the off-stream reservoir into the low-level outlet and to manage reservoir drawdown operations (Figures 9-1 and 9-2). Water will be released from the off-stream reservoir when the river flow rate is at or below 20 m^3/s. The combined flow from the low-level outlet and the flow in Elbow River will be managed so that flow in the river downstream of the its confluence with the unnamed creek does not exceed 47 m^3/s.

As with the service spillway, the release rate from the off-stream reservoir outlet has a linear relationship with water depth. A staff gauge will be installed at the low-level outlet to manage release rates so that Elbow River flows are below 47 m^3/s (i.e., bankfull discharge or point of incipient flooding). Suspended sediments will also be monitored.

Elbow River stream flow monitoring details are provided in Section 9.3.1 above.

9.5.2 Reservoir Depth/Volume

The off-stream reservoir water depth will be monitored to track the reservoir's available volume and holding capacity, assist in managing fish salvage activities in the reservoir and manage the release of water from the off-stream reservoir. Off-stream reservoir depth/volume will be done as described in Section 9.4.2 above.

9.5.3 Turbidity and Suspended Solids

Turbidity and suspended solids will be monitored to:

- determine background TSS levels in Elbow River
- available TSS loading capacity in Elbow River
- whether mitigation measures in the off-stream reservoir need to be implemented during release of water (e.g., adaptively manage the reservoir release rates).

Turbidity monitoring sondes will be installed at both river monitoring stations (i.e., at Bragg Creek [05BJ004] and Sarcee Bridge [05BJ010] in Calgary; Figure 9-1). Continuous TSS monitoring will be conducted with turbidity measurements made at 1-hour intervals.

A temporary turbidity monitoring station will be installed in the low-level outlet below the off-stream reservoir outlet gates (Figure 9-1). This monitoring station will include a turbidity sonde to capture turbidity levels as water is released from the reservoir and prior to entering Elbow River. The turbidity sonde will be installed with telemetry so turbidity monitoring results will be available in real time for staff to use for management water release. The station will be installed prior to water being released and it will remain in place until the off-stream reservoir is empty.

Activities to install the monitoring equipment will be planned in a manner that ensures the safety of monitoring staff.

A turbidity curve will be established to determine the site-specific relationship between turbidity levels and suspended sediment concentrations. This will be done to calculate and predict the suspended sediment loading to Elbow River. These results will be checked against the data collected from the Sarcee Bridge turbidity monitoring. Water license holders situated on Elbow River downstream of the Project, including the Glenmore Reservoir water treatment operator, will be provided turbidity monitoring results to assist with water treatment management decisions.

The turbidity curve will be developed in accordance with Alberta Transportation's "Conversion Relationship Between Nephelometric Turbidity Units (NTU) into mg/L for Alberta Transportations' Turbidity Specification" (Alberta Transportation, [No Date]). The steps to establish the turbidity curve require site samples being sent to a certified lab for TSS analysis; therefor the turbidity curve should be established prior to construction commencing.

9.5.4 Fish Stranding and Rescue Monitoring

Post-flood operations will include monitoring fish in the off-stream reservoir to manage fish entrained in the reservoir. The low-level outlet structure will be operated in a manner that allows fish egress from the off-stream reservoir and into the unnamed creek. Fish monitoring will be necessary to identify shallow areas in the off-stream reservoir that become isolated and strand fish as the water levels drop. This monitoring will be done to inform fish rescue activities.

Monitoring for fish rescue activities will include the following:

- During the release of water, isolated pools will be identified and the potential for fish to become stranded will be assessed.
- Monitoring in and around the outlet structure will observe if and how fish congregate around the outlet and if conditions permit their movement out of the reservoir. Visual monitoring will also include assessing for potential harm or mortality of fish caused by movement through the outlet. A sampling of fish that are injured (e.g., swimming on side and cannot maintain balance) or dead will be captured when safe to do so using dip nets. Observations and photographs of external physical damage to fish will be recorded.
- Water quality in the off-stream reservoir will be monitored using hand-held meters to assess water temperature and dissolved oxygen to inform fish capture and handling methods. If conditions in the reservoir become unfavorable (i.e., low oxygen and elevated temperatures), additional fish rescue crews and equipment will be mobilized.
- Monitoring methods will vary according to conditions and may include the use of a drone to identify isolated pools; accessing shallow pools by crews in boats (e.g., airboats, light rafts with oars and jet motor, kayaks); or by crews on foot if the depth and substrate conditions are safe to wade in.
- When the water has been fully drained from the reservoir, it will be surveyed to identify isolated pools where fish might be stranded.
- Fish will be handled according to conditions set out in the FRL Fish in captivity will be monitored (e.g., water temperature, air bubblers, signs of respiration, acclimation time, etc.) and appropriate adjustments in handling will be made as needed for fish survival.
- Monitoring will be undertaken at a frequency that allows for successful fish rescue based on environmental conditions, including ambient air temperature and the rate of the receding water level.
- Shoreline surveys immediately downstream of the confluence of the unnamed creek with Elbow River will be completed periodically to assess if potentially translocated fish show signs of stress (e.g., swimming on side) or mortality. Adjustments in returning fish to Elbow River will be made, as needed, to mitigate stress to fish (e.g., increase acclimation time).

9.5.5 Water Quality

Water quality samples will be collected in the off-stream reservoir (Figure 9-2) and in the low-level outlet below the reservoir outlet gate on a weekly basis as water is being released.

Water samples will be collected in the off-stream reservoir from a boat using a depth sampler (e.g., Kemmerer or similar) from about mid-depth. The boat will be transported by truck and deployed to the reservoir from a location that can be safely reached by truck. Monitoring staff will maintain a safe distance from the reservoir outlet when using the boat. The boat will have an anchor and paddles in the event the motor malfunctions.

The specific location for water sampling will be determined based on the final configuration of the outlet gates where samples can be obtained safely. Samples will be taken from a location where monitoring staff can easily and safely walk along the side of the unnamed creek and near the water.

A pole sampler can be used from the side of the unnamed creek to reach into and obtain release water. If water released from the reservoir has a low depth and velocity, and not considered too swift for monitoring personnel, they may enter the unnamed creek to obtain water quality samples. One monitoring staff will obtain the water sample while the second monitoring staff remains on standby with the safety throw bag, and radio in the event the collector slips.

Total suspended sediment (turbidity), dissolved oxygen and temperature levels will be sampled/measured in the water during release back into Elbow River. Results will be compared with background levels in Elbow River upstream from the intake structure and diversion channel. If mass balance calculations indicate levels exceed regulatory guidelines at full mixing, then AEP Fisheries Managers will be notified, and additional monitoring of these parameters will occur.

The analytical results will be reviewed to monitor contaminants (e.g., herbicides, oil and grease, etc.) do not enter the off-stream reservoir at levels that compromise water quality in Elbow River. These results will be provided to the City of Calgary water works department and the Glenmore Water Treatment Plant as a measure of due diligence to facilitate Calgary's water treatment program. Water samples will include parameters listed in Table 9-2 and sample collection frequency listed in Table 9-3.

Sampling procedures will include the following:

- Water samples will be collected in laboratory provided sample bottles.
- Sample bottles for inorganic parameters will be triple rinsed with ambient water.
- Methylmercury will be sampled according to laboratory instructions (e.g., clean hands/dirty hands protocol).

- Samples will be stored in coolers and on ice.
- Samples will follow standard labeling and chain of custody protocols
- Samples will be delivered to the selected laboratory on the same calendar day they were collected.
- Insitu water quality parameters including temperature, pH, conductivity, dissolved oxygen and turbidity will be collected in inform each water quality sample.

Table 9-2 Water Quality Monitoring Analytical Sample Parameters

Group	Water Quality Parameter
Routine Ions	electrical conductance, pH, chloride, sodium, potassium, magnesium, calcium, sulphate, fluoride, alkalinity, bicarbonate, hydroxide, carbonate, hardness, total dissolved solids, ion balance, total suspended sediment.
Nutrients,	ammonia, total Kjeldahl nitrogen, nitrite (as N), nitrate (as N), total phosphorus, orthophosphate, dissolved organic carbon, total organic carbon.
Total and dissolved metals	aluminum, antimony, arsenic, barium, beryllium, bismuth, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silicon, silver, strontium, tin, titanium, uranium, vanadium, zinc.
Methyl mercury	Low total mercury, methylmercury.
Hydrocarbons	oil and grease, f1 through F4
Herbicides	will be determined based on weed control program.

Table 9-3 Water Quality Parameter Frequency and Location Monitoring

Monitoring Parameter	Frequency	Location[1]
Total Suspended Sediments (TSS) and Turbidity	Daily	Res, O-C and u/s
Temperature	Daily	O-C and u/s
Dissolved Oxygen	Daily	O-C and u/s
Conductivity	Daily	O-C and u/s
pH	Daily	O-C and u/s
Discharge	Daily	O-C and u/s
Major ions	Weekly	Res, O-C
Total and Dissolved Metals	Weekly	Res, O-C
Nutrients	Weekly	Res, O-C
Methylmercury	Weekly	Res, O-C
Hydrocarbons	Weekly	Res, O-C

NOTE:
[1] O-C – outlet channel (including in the unnamed creek); u/s – Elbow River upstream of the intake structure; Res – off-stream reservoir.

9.5.6 Herbicide Monitoring

Vegetation along the Project components will be maintained and weed growth managed; the application of herbicides to control weeds on site may occur.

If required, herbicides would be applied according the Code of Practice for Pesticides (GoA 2010) which stipulates the minimum distance these chemicals can be used in proximity to a waterbody to avoid contamination in the aquatic environment. Mitigations include the following as stated in Table 8-1:

- restrict herbicide mixing and loading within 30 m of an open body of water
- identify open bodies of water within the application sites
- mark or flag of open bodies of water that will not be clearly visible to the applicator

During the post-flood phase, water quality samples will be collected on a weekly basis (see Section 9.4.7). Water quality samples will be analyzed for relevant herbicides used on site to identify residual chemicals that may enter the aquatic environment.

9.5.7 Indigenous Monitoring

During post-flood operation, Indigenous environmental monitors may provide assistance with the onsite monitoring activities. Environmental monitors whom are properly trained and experienced in safety protocols regarding working in and around water (e.g., swift water training) as well as environmental monitoring techniques can participate in the following activities:

- assist QAES in identifying locations in the reservoir where fish stranding may occur
- monitoring fish health and conditions during fish capture and salvage activities
- complete data recording

9.5.8 Reporting Requirements

Operational monitoring information including staff gauge routine observations at the service inlet and off-stream reservoir, suspended sediment monitoring data, fish rescue date and water quality analysis will be stored electronically for due diligence purposes. This information will be made available in report form as follows.

9.5.8.1 Elbow River Flows

Off-stream reservoir water release management activities and Elbow River flow rate (i.e., discharge from the low-level outlet combined with Elbow River discharge) will be documented and reported to the City of Calgary and Glenmore Reservoir operator to assist in downstream reservoir management.

9.5.8.2 Fish Rescue

Reporting for fish rescue activities will include a fisheries loadform that will be submitted to AEP according the conditions in the FRL; this is considered the fish salvage report. Information to be submitted in the loadform includes a minimum of the following for each fish unless otherwise specified in the FRL:

- reasons for fish capture
- habitat type
- fish capture location and time
- fish species
- fork length
- weight
- sex (if known)
- age or life stage

9.5.8.3 Turbidity, Water Quality, and Reservoir Depth

Water quality and turbidity monitoring reports will be produced during the water release from the off-stream reservoir. These reports will include:

- the weekly water quality sample data in table form
- a summary of Elbow River turbidity results
- a summary of Elbow River hydrology and reservoir depth
- date and environmental conditions the samples were collected

These reports will be provided to the City of Calgary and other water license holders (e.g., Westridge community and Callaway Park) situated on Elbow River downstream of the Project to inform their water treatment programs.

10.0 REFERENCES

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