Alberta Transportation

Special Areas Water Supply Project
Environmental Impact Assessment

Volume II – Environmental Impact Assessment

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ABBREVIATIONS

dBA	A-weighted decibels
AQHI	Air Quality Health Index
AAADMS	Alberta Ambient Air Data Management System
AAAQOG	Alberta's Ambient Air Quality Objectives and Guidelines
AER	Alberta Energy Regulator
AEP	Alberta Environment and Parks
AT	Alberta Transportation
AWRET - A	Alberta Wetland Rapid Evaluation Tool – Actual
BSL	Basic Sound Level
BMP	Best Management Practice
CWMS	Civil Works Master Specification
cfu	Colony Forming Units
CSP	Corrugated Steel Pipe
CAC	Criteria Air Contaminants
DUC	Ducks Unlimited Canada
EC	Electrical Conductivity
ECS	Engineering Confirmation Study
ECO Plan	Environmental Construction Operations Plan
EIA	Environmental Impact Assessment
EPP	Environmental Protection Plan
ESC	Erosion and Sediment Control
DFO	Fisheries and Oceans Canada
FMO	Fisheries Management Objectives
FSL	Full Supply Level
GoA	Government of Alberta
IFN	Instream Flow Needs
IO	Instream Objectives
KI	Key Indicator
KCB	Klohn Crippen Berger Ltd.
LSRS	Land Suitability Rating System
LSA	Local Study Area
MUP	Multiple Use Project
PSL	Permissible Sound Level
RSA	Regional Study Area
ROW	Right-of-way
SAR	Sodium Adsorption Ratio
SPL	Sound Pressure Level
SAWSP	Special Areas Water Supply Project
SSRB	South Saskatchewan River Basin
TBR	Technical Baseline Report
ToR	Terms of Reference
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
WCO	Water Conservation Objectives
WRMM	Water Resources Management Model
WSS	Water Supply System
VEC	Valued Ecosystem Component
ZOI	Zone of Influence

1 ENVIRONMENTAL IMPACT ASSESSMENT

1.1 Background and Objectives

The following presents an Environmental Impact Assessment (EIA) for the Special Areas Water Supply Project (SAWSP or the Project). The purpose of the EIA was to identify and develop mitigation measures to reduce or eliminate known or suspected Project effects within the region in which the SAWSP components are located or proposed. Significant contributions towards cumulative regional effects with adjacent existing or proposed land use developments were also to be identified and addressed through mitigation strategies. The format of the EIA is based on the Government of Alberta's *Environmental Impact Assessment Guidelines* (Government of Alberta 2013a).

1.2 Methodology

Provided in this section is an overview of how potential impacts and their associated effects were identified, assessed (approach and scope), descriptions of the assessment criteria used, the spatial and temporal boundaries employed, and a summary of the assessment results including identification of residual effects and characterization of their significance. The potential environmental effects of the SAWSP components were screened based on a review of existing information, a review of the component descriptions and conceptual designs, typical construction methodology, and field surveys. The potential effects of the SAWSP components were identified and characterized to assess whether residual effects could reasonably be expected to occur following application of mitigation measures.

1.2.1 Assessment Scales

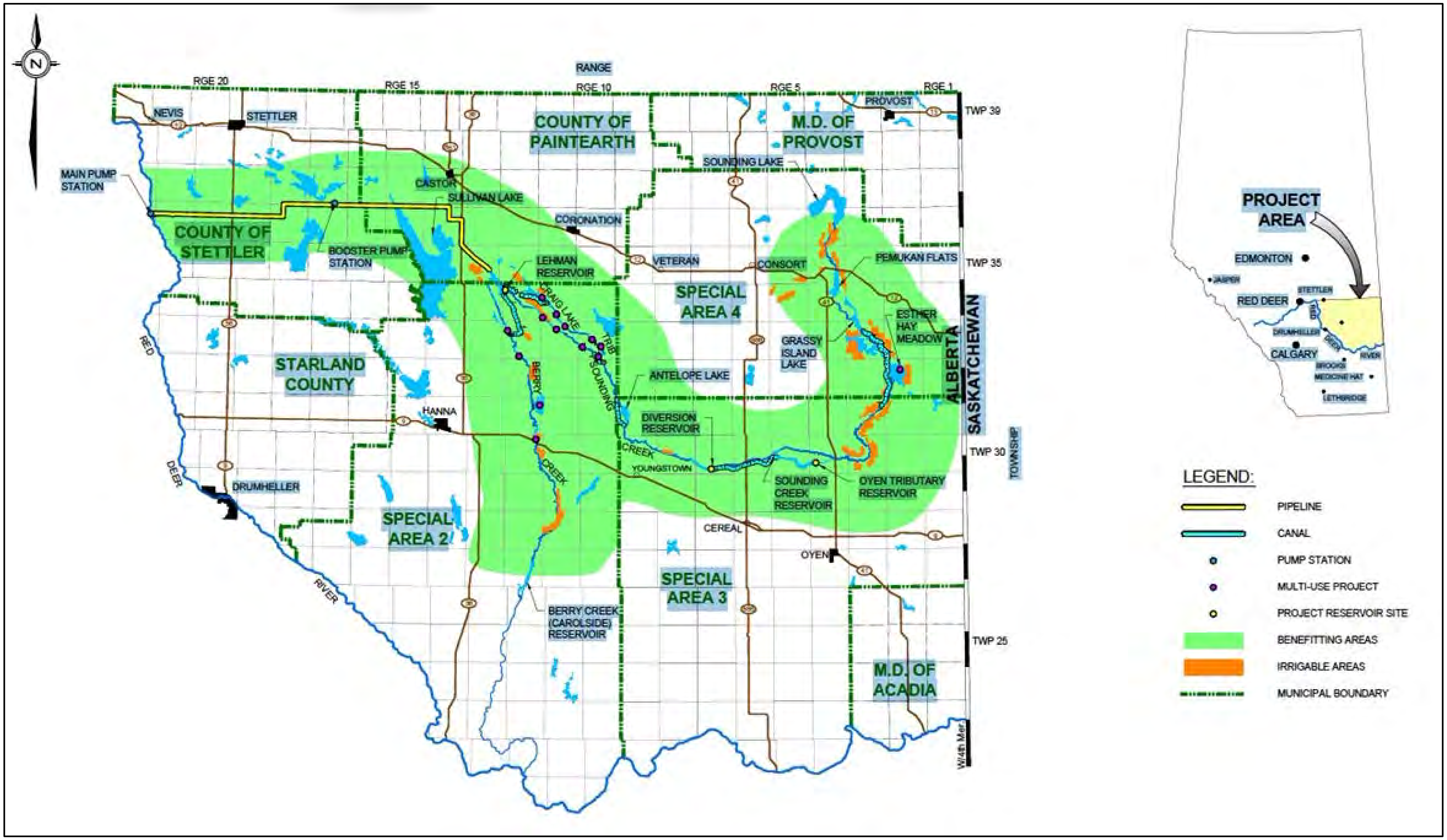
Two scales of assessment were defined for the Project:

- a Regional or General Project scale extent covering the full extent of the SAWSP; and
- a Local Scale assessment covering individual SAWSP components (such as individual reservoirs or systems).

Given the extent of the proposed SAWSP (Figure 1.1), the assessment of the SAWSP as a whole was considered to be a regional scale assessment. Existing or approved projects of the same scale as the SAWSP do not exist in the region and cumulative effects with other projects are not expected at a regional scale.

Local scale environmental evaluations were completed for SAWPS components to assess the potential effects to the local environment associated with the construction and operation of each component.

Figure 1.1 Special Areas Water Supply Project



Local-level assessments were conducted for the following components:

- Water Supply System;
- Lehman Reservoir;
- Oyen Tributary System;
- Craig Lake Bypass Canal;
- Scaupshovel Bypass Canal;
- Antelope Lake Bypass Canal; and
- Esther Hay Meadow Bypass Canal.

Individual Multiple Use Projects (MUPs) were also assessed separately. These included:

- MUP BC-4 Fertility;
- MUP BC-5 Dale;
- MUP BC-7 Contracosta;
- MUP BC-8 Richdale;
- MUP SO-5/6 Motz;
- MUP SO-7 Mitchell;
- MUP SO-10 Wingding;
- MUP SO-11 Scaupshovel;
- MUP SO-39 Esther Hay Meadow;
- MUP CR-6 Craig Lake;
- MUP CR-8 Sneath;
- MUP CR-10 Peter;
- MUP CR-13 Loon Slough; and
- MUP CR-14 Scoville.

Creek channels were expected to require different levels of modifications based on modeled water flows and volumes (Volume I: Appendix I). Some creeks had reaches that were expected to require significant engineering and or modification. Other creeks were predicted to not require modifications with the addition of SAWSP flows. Creeks and segments of creeks were grouped into reaches based on predicted changes (Volume I: Appendix I: Figure 9.1). The creek modifications were assessed in the following groupings:

- Berry Creek;
- Craig Lake Tributary;

- Oyen Tributary;
- Upper Sounding Creek (Volume I: Appendix I: Figure 9 [ends at Reach S8]); and
- Lower Sounding Creek (Volume I: Appendix I: KCB 2015: Figure 9 [Reach S8 to Sounding Lake]).

1.2.2 Study Area Boundaries

The component-level Local Study Areas (LSAs) were defined as the spatial extent to which potential effects from Project component activities were expected (Digital Map Package). The assessment of the vast SAWSP at a component scale required multiple LSAs, one for each of the components listed above. To simplify the assessment of local effects, none of the LSAs overlapped spatially. The potential environmental effects of the SAWSP were assessed once for a given location. Potential Project effects at a regional scale are addressed either a discussion of general effects that would occur across the SAWSP footprint (Section 1.3), or where effects would be additive between Project components (Section 2). Existing or proposed operations that may act cumulatively with the SAWSP and lead to significant cumulative effects were uncommon. The potential for cumulative effects are addressed in sections where appropriate.

The temporal extent of the assessed potential Project effects was limited to the Construction Phase and the Operation Phase of the Project. The decommissioning of the successful construction and loss of the inherent benefits the Project was not anticipated. The potential effects of the anticipated phases of the SAWSP were assessed relative the Baseline Conditions as defined in the Technical Baseline Reports (TBRs). The TBRs are provided in Volume 4.

1.2.3 VEC and KI Identification

The assessment of the potential effects of the SAWSP on every aspect of an ecosystem, social condition, and economic scenario is not practical or achievable. Valued Ecosystem Components (VECs) provide a means to focus the evaluation of SAWSP effects and assess the significance for residual adverse environmental effects on representative components that have the most relevance to decision-making processes.

In complex systems, representation of a multitude of elements can be further represented by Key Indicators (KIs). Multiple KIs can be identified for a single VEC to best represent the Baseline Conditions for the VEC and to provide multiple pathways to assess the potential effects to each VEC.

1.2.3.1 Air Quality and Noise

Air quality was included as a VEC to assess the SAWSP’s potential to affect the health and well-being of humans, wildlife, vegetation, and other biota. As part of the atmospheric environment, air can act as a conduit or pathway for transporting potential contaminants, such as dust and emissions, to freshwater, terrestrial, and human environments.

Noise was included as a VEC due to the effects of noise to the health and well-being of humans and wildlife. Noise exposure has been linked to adverse effects such as sleep disturbance and agitation

(Health Canada 2011). Noise has the potential to disturb wildlife and reduce the suitability of habitat for wildlife adjacent to activity and disturbance.

1.2.3.2 Surface Water Quality and Quantity

Water quality and quantity are principal aspects of the SAWSP. Towards the assessment of the VEC, the following KIs were used to determine potential effects to surface water:

- streamflows;
- MUP and reservoir water levels (surface water extent); and
- surface water quality.

1.2.3.3 Hydrogeology

In addition to surface water, groundwater was included as a VEC. The potential effects of the SAWSP on hydrogeology was assessed through the KIs of:

- groundwater quantity; and
- groundwater quality.

1.2.3.4 Fish and Aquatic Habitat

Fish and aquatic resources represent an important resource that has been identified as a VEC for the Project. The following KIs were selected to help evaluate the potential effects of the Project and to establish metrics for monitoring:

- northern pike (*Esox lucius*), a spring spawning sport fish in Carolside Reservoir;
- forage fish species, including fathead minnow (*Pimephales promelas*) and brook stickleback (*Culaea inconstans*) which occur throughout the Study Area; and
- aquatic habitat, including benthic and planktonic invertebrate populations, substrate composition, and aquatic vegetation.

1.2.3.5 Soils and Terrain

Environmental effects on the VEC of soil and terrain were evaluated using three KIs. Three KIs relating to soil and terrain were:

- soil quality;
- soil biodiversity; and
- alterations to terrain.

1.2.3.6 Vegetation and Wetlands

Environmental effects on the VEC of vegetation and wetlands were evaluated using four KIs:

- rare plants and rare plant habitat;

- rare plant communities;
- native grasslands, and
- wetlands and wetland plant communities.

1.2.3.7 Wildlife and Wildlife Habitat

To improve the effectiveness and efficiency of the TBR, specific species at risk were chosen as KIs to represent the wildlife VEC. The selection of KIs allowed for an efficient assessment focused on a few species, with the results and conclusions to be applied to numerous other species and their associated habitats. The KIs were representative of specific communities or ecosystems which helped to indicate certain environmental or ecological conditions. Their presence was used as a sign of the overall health of their ecosystems. Through the determination of the presence and relative abundance of the KIs, how changes in the environment may likely affect the other species that share that habitat were extrapolated.

The selection of the KIs for the SAWSP was based on federally and/or provincially listed species that have recovery plans applicable to other species of management concern or other wildlife in general. The selected KIs for the SAWSP represented a diversity of habitat types such as grassland, sedge wetlands, shrubs, ephemeral wetlands, alkali flats, and permanent wetland habitats. The KIs selected for the SAWSP were:

- Burrowing Owl (*Athene cunicularia*);
- Yellow Rail (*Coturnicops noveboracensis*);
- Loggerhead Shrike (*Lanius ludovicianus*);
- Baird's Sparrow (*Ammodramus bairdii*);
- Piping Plover (*Charadrius melodus*); and
- Canadian Toad (*Bufo hemiophrys*).

1.2.3.8 Land Use and Management

Environmental effects on the VEC of Land Use and Management were evaluated using five KIs:

- land access and infrastructure;
- livestock;
- crop production;
- forage production; and
- land use patterns.

1.2.3.9 Infrastructure

The assessment of potential effects to infrastructure did not utilize KIs. The potential effects to infrastructure was assessed through an evaluation of SAWSP components against existing infrastructure.

1.2.3.10 Historical Resources

Environmental effects on the VEC of Historical Resources were evaluated using two KIs:

- Archaeological resources; and
- Palaeontological resources.

1.2.4 Residual Effects Assessment

The objective of the environmental assessment was to determine if residual effects were predicted after the application of mitigation strategies and industry standard practices. Where mitigation measures were expected to be effectively implemented, and no or negligible changes to the environment were predicted, the potential effects were not carried forward to characterization. Project impacts predicted to have uncertain effects to the environment after mitigation were characterized to assign a final significance. The significance of residual effects was characterized in terms of Direction, Magnitude, Geographic Extent, Duration, and Reversibility (Table 1.1).

Table 1.1 Residual Effect Rating Descriptors

Direction	Magnitude	Geographic Extent	Duration	Reversibility
Positive (P): The anticipated effect would be positive	**Negligible (N):** No detectable change from Baseline Conditions	**Local (L):** Effect is limited to the SAWSP footprint or LSA	**Short-Term (ST):** Effect is removed with the completion of construction.	**Short-Term (ST):** Effect can be reversed within 10 years
Neutral (Ne): The anticipated effect is neutral	**Low (L):** Differs from the average value for Baseline Conditions, but within the range of natural variation	**Regional (R):** Effect extends to RSA	**Medium-Term (MT):** An effect that is present after construction but diminishes during the lifespan of the SAWSP	**Medium-Term (MT):** Effect can be reversed between 10 to 25 years
Negative (N): The anticipated effect would be negative	**Moderate (M):** Differs from the average value for Baseline Conditions and approaches the limits of natural variation		**Long-Term (LT):** Effect lasts the lifespan of the SAWSP	**Long-Term (LT):** Effect can be reversed within between 25 to 100 years
Unknown (Unk): Insufficient information to determine direction	**High (H):** Predicted to differ from Baseline Conditions or a guideline or threshold value so that there would be a detectable change beyond the range of natural variation		**Far Future (FF):** An effect predicted to be present after the lifespan the SAWSP	**Irreversible (IR):** Effect cannot be reversed

Significance was determined through a cumulative evaluation of the characterizations. Residual effects were classified as either significant (S) or not-significant (NS). A significant effect was one that meets any of the following criteria:

- an effect that is determined to permanently or have far-future, adverse effects on air quality, noise disturbance, surface water quality, groundwater, geomorphology, native soils, historical resources, and socio-economic conditions;
- an effect predicted to negatively affect individuals and or critical habitat of species of conservation concern (‘Endangered’ or ‘Threatened’ species);
- an effect predicted to negatively affect the presence and or access to species of management concern (important socio-economic and traditional use species); and

- an effect predicted to affect the sustainability of regional populations of fish, wildlife; wetlands and native vegetation.

Significant residual effects would need to be addressed prior to the construction of the SAWSP.

1.3 General SAWSP Assessment

The SAWSP is comprised of many individual components and the potential effects of the SAWSP could span multiple components. General mitigations that would be applicable during the construction and operation of the SAWSP are first presented. Potential effects specific to each of the VECs are then outlined, assessed against Baseline Conditions, and additional mitigation strategies, where they may be required, are discussed within each of the VEC sections. Tabular summaries of the general assessments are provided in Appendix I. Local scale environmental evaluations completed for each of the components described in Section 1.2.2, are provided in Section 2.

1.3.1 Standard Mitigations

Alberta Transportation's practices and policies would be the primary controls to minimize or remove most of the potential Project effects. The practices and policies include:

- Alberta Transportation's (AT) *Environmental Protection Plan for the Planning and Construction of Water and Transportation Projects* (EPP). The EPP outlines the standard measures that AT would use to prevent or mitigate environmental impacts resulting from construction activities (Appendix II).
- In accordance with AT's *Environmental Construction Operation Plan Framework 2017 Edition* (Appendix III), a site-specific Environmental Construction Operations Plan (ECO Plan) would also be prepared by the Contractor.
- The AT *Civil Works Master Specifications* (CWMS) outlines best practices for contractors (Appendix IV).
- The AT *Environmental Management System Manual* (EMS Manual) provides procedures and policies that would guide both AT and contractors through regulatory requirements and provides environmental best practices to be used during the construction and maintenance of Alberta's water infrastructure (Appendix V).
- Finally, the AT *Erosion and Sediment Control Manual* (ESC Manual) provides guidelines for the design, construction, and maintenance of erosion and sediment control structures. The ESC Manual gives direction for the analysis and design of erosion and sediment control structures at construction sites (Appendix VI).

Mitigations that may be specific to VECs which are not included in the AT standard practices and policies, are included for the VECs below.

1.3.2 Air Quality and Noise

1.3.2.1 Potential Project Effects

Air Quality

Overall air quality is fundamentally important to the health and well-being of humans, wildlife, vegetation and other biota. The following Criteria Air Contaminants (CACs) as identified by Environment Canada (Environment Canada 2013) and adopted in Alberta (Government of Alberta 2017) may cause adverse environmental impacts, including, aesthetic, visibility, and/ or toxic effects (BC MOE 2013):

- Sulphur Oxides (SO_x)
- Nitrogen Oxides (NO_x)
- Particulate Matter (PM)
- Volatile Organic Compounds (VOC)
- Carbon Monoxide (CO)
- Ammonia (NH_3)
- Ground-level Ozone (O_3)

Construction activities and operations may create emissions which could increase levels of CACs near Project Site activities. Potential emission sources and associated CACs are discussed below, though in general these may include: mobile equipment, soil stockpiles, haul roads, and excavation activities (Appendix I: Table I-1).

The following sections identify or assess:

- potential air emission sources associated with the Project;
- sensitive human and ecological receptors near the site;
- applicable guidelines for evaluating air quality; and
- the potential effects to humans and wildlife at identified receptor locations.

Alberta's Ambient Air Quality Objectives and Guidelines (AAAQOG) are regulated under the Alberta *Environmental Protection and Enhancement Act* (R.S.A. 2000, c. E-12). The AAAQOGs are generally established for one-hour, 24-hour, and annual averaging periods, but other periods may be used based on underlying information or ambient monitoring methods (Government of Alberta 2017). The AAAQOGs for contaminants which may be associated with emissions from construction activities at the Project Site are summarized in Table 1.2 below.

Table 1.2 Alberta Ambient Air Quality Objectives

Contaminant	Averaging Time Period	Ambient Air Quality Objectives ($\mu g/m^3$)
Carbon Monoxide (CO)	1 hour	15,000
	8 hour	6,000
Nitrogen Dioxide (NO_2)	1 hour	300
	Annual	45
Sulphur Dioxide (SO_2)	1 hour	450
	24 hour	125
	30 day	30
	Annual	20
Total Suspended Particulate Matter (TSP)	24 hour	100
	Annual (geometric)	60
Particulate Matter <2.5 microns ($PM_{2.5}$)	1hour	80

Receptor Identification

Boundaries were defined near the SAWSP footprint to identify receptors which may be adversely affected by air quality impacts from SAWSP related activities in accordance with the Alberta Air Quality Model Guideline (Government of Alberta 2013b) and Environmental Impact Assessment Guidelines (Government of Alberta 2013a) human receptors were identified within a 10 km radius and ecological receptors were identified within a 5 km radius. The localized boundary was identified as the Project sites for construction activities.

Ecological Receptors

Various wildlife species were identified within a 5 km radius of the proposed areas of impact, many of which are considered species at risk by the federal Species at Risk Public Registry (Government of Canada 2018), the Alberta *Wildlife Act* (Government of Alberta 2015a), and/or the Alberta Wild Species General Status Listing (Government of Alberta 2015b). The ecological receptors included in the assessment were:

- American Badger (*Taxidea taxus*)
- Baird's Sparrow (*Ammodramus bairdii*)
- Barn Swallow (*Hirundo rustica*)
- Barred Owl (*Strix varia*)
- Bobolink (*Dolichonyx oryzivorus*)
- Burrowing Owl (*Athene cunicularia*)
- Canadian Toad (*Anaxyrus hemiophrys*)
- Chestnut-Collared Longspur (*Calcarius ornatus*)
- Ferruginous Hawk (*Buteo regalis*)
- Loggerhead Shrike (*Lanius ludovicianus*)
- Long-Billed Curlew (*Numenius americanus*)
- Northern Leopard Frog (*Lithobates pipiens*)
- Peregrine Falcon (*Falco peregrinus*)
- Plains Spadefoot Toad (*Spea bombifrons*)
- Prairie Falcon (*Falco mexicanus*)
- Rusty Blackbird (*Euphagus carolinus*)
- Short-Eared Owl (*Asio flammeus*)
- Sprague's Pipit (*Anthus spragueii*)
- Trumpeter Swan (*Cygnus buccinator*)

Human Receptors

Human receptors were identified from three residence / landowner maps acquired from Stettler County, the Special Areas Board, and the County of Paintearth No. 18. The human receptors identified within a 10 km radius of the proposed area of impact include users of recreational areas and provincial parks, rural residences, and residents of Castor, Esther and Spondin (Digital Map Package).

Esther (5-29-031-02 W4) is an unincorporated community located approximately 2.5 km east of the proposed SAWSP Canal. Spondin (13-23-033-12 W4) is an unincorporated community located approximately 4 km from an area of proposed significant channel impacts.

Sources of Emissions

The construction phase of the SAWSP is anticipated to last 3 to 4 years and would be conducted seasonally, typically from May to October. The pipeline and canals would be linear features and it is anticipated that they would be constructed sequentially with individual sections under construction for less than a month at a given locattion. It is anticipated that dams and associated structures would be under construction in a single season or approximately 6 months. It is assumed that air emission rates and noise levels during the life of the construction phase would remain consistent throughout the construction period.

The SAWSP construction phase would consist of:

- construction and installation of a pumpstation and intake;
- construction of the discharge pipeline, the main pipeline, damns and storage reservoirs, and bypass channels;
- development of infrastructure for MUPs;
- movement of construction materials along local highways and gravel roads;
- stockpiling of topsoil and overburden; and
- excavation of various dam and outlet areas.

For these tasks, different types of equipment would be utilized, including a number of machines and devices varying in physical size, horsepower rating, and mode of operation. Consequently, the air and noise emissions produced would be expected to vary.

Equipment on the individual Project construction areas would potentially consist of:

- Pumpstation – Several large backhoes, tandem haul trucks for gravel, semi-trucks and flatbed trailers to haul reinforcing steel and pump components and building materials, concrete trucks, cranes for lifting components, compactors, pickup trucks for crews.
- Pipeline (1,200 mm diameter) – Several large backhoes for trenching, pipe placement and backfill, pipe delivery trucks, compactors, crew pickup trucks.
- Dams and canals – Earthmoving scrapers (CAT 631 size), dozers (CAT D9), graders, compactors, tractors and discs, watering trucks, excavators, tandem trucks for gravel haul, crew pickup trucks, concrete trucks, other materials delivery trucks. There could be rock trucks (CAT 769 or equivalent) used instead of or in addition to scrapers.

Construction activities at the site would result in releases of particulate matter of varying sizes, carbon monoxide, SO_x and NO_x to the atmosphere. A list of the construction activities classified as air emission sources which are expected to be found at the SAWSP site and can be quantitatively assessed are provided in Table 1.3. Air emissions associated with mobile equipment, earthworks, stockpiles and other activities are described.

Table 1.3 Summary of Air Emission Sources

Source	Contaminant Type (Air)
Heavy Duty Equipment	NOx, CO, TSP, $PM_{2.5}$, PM_{10}
Personal Transportation Vehicles	NOx, CO, TSP, $PM_{2.5}$, PM_{10}
Water Trucks	NOx, CO, TSP, $PM_{2.5}$, PM_{10}
Semi and Flatbed Haul Vehicles	NOx, CO, TSP, $PM_{2.5}$, PM_{10}
Material Handling	TPM, $PM_{2.5}$, PM_{10}
Stockpile(s)	TPM, $PM_{2.5}$, PM_{10}
Unpaved Road Dust	TPM, $PM_{2.5}$, PM_{10}

Abbreviations:
NOx – Nitrogen Oxide; CO – Carbon Monoxide; SO_2 – Sulphur Dioxide; TPM – Total Particulate Matter, $PM_{2.5}$ – Particulate Matter <2.5 microns; PM_{10} – Particulate Matter <10 microns;

Noise

Construction of the proposed SAWSP has the potential to affect levels of ambient noise near construction sites. Noise generated by SAWSP related activities on site may increase local ambient noise levels and potentially impact human and ecological receptors. Sources of potential noise pollution relating to the Project include transport and construction vehicles and heavy-duty equipment.

The noise assessment considered the effect of SAWSP related noise emissions during the construction phase, and how these emissions may alter the existing ambient noise levels in the area. Estimates of predicted noise levels from construction and operation phases of the SAWSP were not calculated. However, noise levels associated with Project activities have been assessed for the potential to contribute to local noise levels.

The following sections identify or assess:

- potential noise and vibration sources associated with the Project;
- sensitive human and ecological receptors near the site;
- potential noise levels associated with the proposed Project;
- applicable guidelines for evaluating noise pollution; and
- the potential effects to humans and wildlife at identified receptor locations.

Noise limit guidelines for the construction of water infrastructure are not available. Directive 038: Noise Control Guidelines as set by the Alberta Energy Regulator (AER 2007) were used as surrogate guidelines. AER (2007) defines a Permissible Sound Level (PSL) as the maximum noise level which should not be exceeded at a point 15 m from the nearest or most impacted dwelling unit. The

Directive states that *"New facilities must not exceed a sound level of 40 dBA Leq (nighttime) at 1.5km from the facility fence line if there are no closer dwellings."*

To account for time variations in environmental noise, the PSL uses a single number descriptor: an 'average' sound level-known as energy equivalent sound level or L_{eq}. The L_{eq} is the energy-averaged A-weighted sound level for a specified time period. The A-weighted sound level is the sound level as measured using a setting that emphasizes the middle frequency components similar to the frequency response of the human ear at levels typical of rural backgrounds in mid frequencies (AER 2007). It is the steady, continuous sound level over a specified time period that has the same acoustic energy as the actual varying sound levels occurring over the same time period. The L_{eq} values are based on A-weighted sound levels expressed in units of dBA (A-weighted decibels). The A-weightings are assigned to reflect the response of the human ear to different frequencies of sound. AER (2007) defines Basic Sound Levels (BSLs) at night, as shown in Table 1.4.

Table 1.4 Basic Sound Levels for Nighttime (22:00 – 07:00)

Proximity to Transportation	Dwelling Unit Density Per Quarter Section of Land		
	1-8 dwellings: Nighttime (dBA Leq)	9-160 dwellings: Nighttime (dBA Leq)	>160 dwellings: Nighttime (dBA Leq)
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

Notes:

Category 1: Dwelling units more than 500m from heavily traveled roads or rail lines and not subject to frequent aircraft flyovers.

Category 2: Dwelling units more than 30m but less than 500m from heavily traveled roads and/or rail lines and not subject to frequent aircraft flyovers.

Category 3: Dwelling units less than 30m from heavily traveled roads or rail lines and/or subject to frequent aircraft flyovers.

Receptor Identification

The spatial boundary for identification of receptors for the noise assessment was defined as a 1.5 km area surrounding the proposed Project Footprint (Digital Map Package). The boundary was used to identify human and ecological receptors which may be exposed to noise impacts resulting from construction activities at the Project sites.

The sensitive receptors within the study area include both human and ecological receptors. There were no residences, hospitals, libraries, schools, places of worship or other facilities where quiet is an important attribute of the environment within the area potentially impacted by the proposed SAWSP.

Ecological Receptors

The species identified as ecological receptors for the air impact assessment were the same for the noise impact assessment.

Human Receptors

There were approximately 93 residences within 1.5 km of the Project (Digital Map Package). These residences were considered sensitive receptors which may be adversely affected by increased noise levels associated with Project activities.

The closest town to the proposed SAWSP was Castor, located approximately 7.5 km to the north of the proposed SAWSP. Due to the spatial dissipation of noise relative to distance and the receptor-based guideline values, the effect of SAWSP generated noise was expected to be local and, as a result, a regional noise study area was not identified.

Based on research conducted by the Environment Council of Alberta, the average rural ambient sound level at nighttime in Alberta is about 35 dBA L_{eq} and the BSL was determined to be 40 dBA L_{eq}. The daytime adjustment recognizes that daytime ambient sound levels are commonly 10 dBA L_{eq} higher than nighttime levels. The daytime period is 07:00 to 22:00, and the daytime adjustment is 10 dBA L_{eq} above the nighttime (AER 2007). SAWSP activities have the potential to affect noise levels. While the SAWSP is not an energy SAWSP, the Alberta Energy Regulator (AER) Directive 038 was used as a guideline to assess the potential effects of noise associated with the SAWSP. Noise from short-term activities (e.g., drilling and servicing rigs) are not typically included in a noise assessment (AER 2007); however, the greatest source of noise associated with the construction of the SAWPS would be construction equipment.

Noise Sources

During the construction phase the major sources of environmental noise associated with SAWSP activities are:

- on-site heavy-duty machinery operation;
- loading, stockpiling, and excavation activities; and
- SAWSP related traffic.

Exact working locations and details for all pieces of equipment were not available at the time of this study. A list of the construction equipment classified as noise sources which are expected to be used during construction are provided in Table 1.5. The table provides the A-weighted Sound Pressure Level (SPL) in dBA for each noise source (AER 2007). The SPL is the decibel equivalent of the pressure of sound waves at a specific location, which is measured with a microphone. The SPL is given in dBA for each noise source to approximate human hearing response at low intensities (AER 2007). These SPLs were not assessed against PSLs. The equipment may also not be an accurate representation of actual equipment which would be used during construction. Rather the information is presented to illustrate that increased noise levels have been associated with the activities and equipment which may be conducted and used. Also, the potential SPLs listed in Table 1.5 are measured at the source. Attenuation between the source and the receptor would mean the SPL that reaches the receptors would be lower.

Table 1.5 Sound Power Level Frequency Spectrum for Potential Noise Sources during Construction

Source	Data Source	Potential Noise Levels Overall (dBA)
Komatzu HM300	HM300-1 Technical Report (Komatsu 2005)	108
CAT 980H	Equipment Spec Sheet	107
CAT D6T	Equipment Spec Sheet	113
CAT IT28B	BS5228-1:2009 Table C6 (34 Wheeled loader 184kW) (BSI Group 2009)	104
CAT 12M-VHP	Equipment Spec Sheet	105
JD 310SK	Equipment Spec Sheet	105
JD 329D	BS5228-1:2009 Table C4 (12. Wheeled excavator 63kW) (BSI Group 2009)	105
Altec AC23-95B	BS5228-1:2009 Table C4 (46. 240kW) (BSI Group 2009)	95
Bus	City of Ottawa Environmental Noise Control Guidelines (City of Ottawa 2006) 88-94 @50feet	123
F350 XLT Pick Up	FHWA Roadway Construction Noise Model User's Guide (US Department of Transportation 2006)	75
Water Truck Ford 8000 with tank	BS5228-1:2009 Table C6 (No. 38) (BSI Group 2009)	111
Vacuum Truck	FHWA Roadway Construction Noise Model User's Guide (US Department of Transportation 2006)	75
CAT CB44B	BS5228-1:2009 Table C6 (34 Wheeled loader 184kW) (BSI Group 2009)	103
SkyTrak 10054	BS5228-1:2009 Table C4 (BSI Group 2009)	98
XCMG RT60 Crane	BS5228-1:2009 Table C4 (12. Wheeled excavator 63kW) (BSI Group 2009)	98
Miller Zoom Boom 535-140	BS5228-1:2009 Table C4 (46. 240kW) (BSI Group 2009)	98

1.3.2.2 Baseline Conditions

Air Quality

In the absence of site-specific ambient air quality data, the ambient air quality data from regional monitoring stations was used as a proxy for air quality in the SAWSP region. Prior to the creation of the Airdata air quality data warehouse (Government of Alberta 2018a), regional data was available from the Alberta Ambient Air Data Management System (AAADMS). Unlike the AAADMS, archived Air Quality Health Index values AQHI beyond 365 days are no longer available in the Airdata air quality data warehouse. Data from Calgary, Medicine Hat, Caroline and Breton weather stations from 1994 to 2014 were obtained prior to the creation of Airdata. Recent AQHI data collected hourly between from July 2017 and July 2018 was obtained for stations located at Red Deer, Airdrie, Calgary, and Medicine Hat.

The AQHI is a tool developed by health and environmental professionals to communicate the health risk posed by air pollution. Historically, other air quality indices have reported air quality in term of air quality objectives for different pollutants and address each pollutant separately. The AQHI presents the immediate health risk of the combined effects of air pollution. The AQHI is measured on a scale ranging from 1 to 10:

- 1-3 indicates a low health risk;
- 4-6 indicates a moderate health risk;
- 7-10 indicates a high health risk; and
- 10+ indicates a very high health risk.

The AQHI is designed as a guide to understand the relative risk presented by common harmful air pollutants. Three pollutants have been chosen as indicators of the overall mixture:

- Ground-level Ozone: Formed by photochemical reactions in the atmosphere, this pollutant mainly comes from vehicle and industrial emissions. It can be a major component of smog during the summer, especially during hot sunny weather, but is generally low in the winter. Ozone can be transported long distances within a polluted air mass and can be responsible for large regional air pollution episodes.
- Fine Particulate Matter: A mixture of tiny airborne particles that can be inhaled deep into the lungs. These particles can either be emitted directly by vehicles, industrial facilities, from natural sources like forest fires, or formed indirectly because of chemical reactions among other pollutants. Particulate matter can reflect local air pollution sources and widespread air pollution.
- Nitrogen Dioxide: Released by motor vehicle emissions and power plants that rely on fossil fuels, nitrogen dioxide contributes to the formation of the other two pollutants.

Data for additional parameters, as detailed below, which may be used to assess ambient air quality or determine baseline concentrations for detailed modeling and assessments is available for the four stations.

- Carbon monoxide (CO);
- Hydrogen Sulphide (H_2S);
- Methane (CH_3);
- ozone (O3);
- fine particulate matter (PM2.5);
- nitrogen dioxide (NO2); and
- sulphur dioxide (SO2).

From 1994 to 2014, the mean AQHI for the Calgary East, Crescent Heights, Caroline, and Breton stations were; 3.2, 2.1, 2.3, and 2.5, respectively. From July 2017 to July 2018, the mean AQHI for the Red Deer, Airdrie, Calgary and Medicine Hat stations were; 2.6, 2.7, 3.0, and 2.6 respectively.

Noise

The nearest dwelling unit is 36 m from the proposed alignment of the Water Supply System (WSS) and would be a Category 2 dwelling unit. A dwelling unit was defined as a permanent or seasonally occupied dwelling with the exception of an employee or worker residence, dormitory or construction camp within an industrial plant boundary (AER 2007). Ninety-three occupied dwellings exist within 1.5 km of the SAWSP, with an average distance between the SAWSP and occupied dwellings of approximately 700 m (Digital Map Package).

1.3.2.3 Mitigation Strategies

Air Quality

A number of mitigation measures are proposed to minimize potential impacts from activities that can cause air emissions (Appendix I: Table I-1). Summarized, these mitigation measures include:

- fugitive dust emissions on site roads would be controlled by the application of water or other dust suppressants at regular intervals;
- mud would be removed from paved roads and access points;
- heavy vehicles transferring stockpiled materials across the site would be fitted with appropriate sheeting and covers for dust control;
- dust filters and dust containment measures would be used during drilling and blasting activities;
- material handling areas, such as loading and unloading, and transfer points would be designed to suppress the generation of fugitive dust;
- stockpiles and storage areas would be wetted to suppress dust, when necessary;
- as practicable, soil stockpiles would be placed in areas least prone to impact from prevailing winds;
- when required, dust generating construction activities would be suspended during periods of excessive winds if dust suppression measures are not working adequately;
- equipment would be in compliance with federal, provincial, regional district, and municipal regulations and standards for emissions;
- combustion engines would be located away from sensitive receptors and would be inspected and maintained regularly;
- uncontrolled burning of waste on site would be prohibited; and
- water or other dust suppressants would be applied to large arid surfaces (e.g., stockpiles, haul roads and plant site) on a regular basis during dry weather conditions.

Greenhouse gas emissions are managed under *A Guide to Energy Efficient Best Practices* (ARHCA-GoA 2012). The guidelines provide examples of how to reduce greenhouse gas emissions and improve energy efficiencies of construction works.

Noise

Mitigation measures would be adopted during the construction phase, and during maintenance or operational activities as a precaution and in accordance with AT standard construction best management practices (BMPs) (Appendix I: Table I-1).

The following measures for noise mitigation are anticipated to be included:

- Mechanical components would be enclosed where possible or positioned in sheltered locations. Stationary equipment generating more than 85 dB (L_{MAX}) would be housed in temporary enclosures.
- Construction activities would be limited to daytime periods.
- internal combustion engines would be fitted with appropriate muffler systems where feasible.
- Activities would take advantage of acoustical screening from existing buildings and topography to shield receptors from construction equipment noise.
- Regular maintenance of mechanical components and construction vehicles would be carried out to reduce noise impact.
- Access roads from site entrances to working areas would be maintained.
- Equipment of the necessary size and power would be used for each task and would be operated within specification and capacity (i.e., they would not be overloaded).
- The use of sirens and reversing alarms would be restricted to the minimum required.

Suitable noise protection measures would also be put in place for construction site workers to limit negative human health impacts. These worker-protection measures would include the wearing of ear mufflers and other noise protection devices on the construction site in areas where noise levels warrant such protection.

1.3.2.4 Assessment of Effects

Air Quality

Based on the interpretation of AQHI data, and the relatively low population and very limited industrial activity within the Special Areas region, the baseline air quality in the Special Areas is predicted to fall between 1 and 2 on the AQHI scale. Based on the presumed baseline air quality, the short duration of the construction works, the equipment proposed to conduct the work, and the implementation of best practices during construction; significant, residual, adverse effects to local or regional air quality are not are expected. Significant cumulative effects on air quality are not expected due to very limited additional sources of emissions across the Special Areas region.

Noise

Noise emissions during construction of the SAWSP would be expected. Construction noise guidelines for construction are based on the non-residential noise bylaws for the City of Calgary. The guidelines allow for noise levels to reach 75 dB during the day for a maximum of 1 hour, in total per day, 80 dB during the day for a maximum of 30 minutes, in total per day and 85 dB during the day for a maximum of 15 minutes, in total per day. Where noise levels may exceed the daytime maximums, “best-neighbour” policies would be implemented to keep residents informed of construction locations and schedules. The open management of the construction would allow residents to plan for temporary disruptions and for best management of herd rotation. With mitigation strategies in place, the potential effects of excessive noise of the SAWSP would be expected to be localized, short in duration, and temporary. A policy for work to occur only during daylight hours would remove potential noise effects to residents and wildlife at night. In general, the effects of SAWSP noise are not expected to be significant. Significant cumulative effects of noise are not expected due to very limited additional sources of noise across the Special Areas region.

1.3.3 Surface Water Quality

1.3.3.1 Potential Project Effects

Construction

Surface water quality in the SAWSP could potentially be affected during construction as a result of:

- introduction of deleterious substances to water bodies; and
- erosion and sedimentation.

Introduction of Deleterious Substances

The release of chemicals required during construction (e.g., gasoline or diesel fuel for vehicles and equipment, solvents, hazardous materials or wastes) into the environment could impact water quality in the SAWSP. These substances could potentially enter water bodies directly or be deposited in the riparian area and be transported into the water body by surface runoff.

Erosion and Sedimentation

Construction activities associated with construction of instream structures such as dam embankments, outlet structures, and spillway channels have the potential to result in release of sediment into aquatic habitats through direct disturbance or surface runoff over disturbed work areas.

Regional Water Quality

Surface water quality in waters connected to the SAWSP could potentially be affected during construction if local impacts occurred and were not mitigated.

Operation

Surface water quality in the SAWSP could potentially be affected during future operation as a result of:

- introduction of deleterious substances to water bodies during maintenance activities;
- introduction of methylated mercury from flooded vegetation;
- erosion and sedimentation from wind, wave, and surface runoff at the new Full Supply Levels (FSLs) of reservoirs and increased streamflow within existing creek channels; and
- diversion of Red Deer River water to existing creeks, reservoirs, and proposed reservoirs.

Introduction of Deleterious Substances

As with construction, the release of chemicals required during reservoir operation and maintenance (e.g., gasoline or diesel fuel for vehicles and equipment, solvents, hazardous materials or wastes) into the environment could impact water quality in the SAWSP.

Introduction of Methylated Mercury

Methylmercury formation tends to be highest in anaerobic environments that have new sources of organic matter (e.g., shallow surface sediments where decaying vegetation may deposit) (Wright and Hamilton 1982). Methylmercury both bioaccumulates and biomagnifies (Boudou and Ribeyre 1997). This is because the addition of a methyl group to mercury greatly increases its ability to be absorbed (~95% of an oral dose absorbed into the bloodstream) and retained by the body (it is poorly metabolized, and it is eliminated to a small extent). The presence of even relatively low concentrations of methylmercury in the aquatic environment is of high concern because it bioaccumulates very efficiently in fish and other aquatic organisms. People and wildlife could be exposed to methylmercury by consuming contaminated fish (Magos 1997).

Erosion and Sedimentation

An increase in water levels to the FSL of reservoirs and MUPs would increase the perimeter of the shoreline susceptible to wind, wave, and surface runoff erosion. Given that the increase in erosion potential would be roughly proportionate to the increase in FSL, there may be elevated concentrations of suspended sediment in localized areas of active erosion, but the average condition within reservoirs and MUPs would not be expected to change during long-term operation. There would likely be a spike in sediment mobilization during initial operation as inundated terrestrial vegetation breaks down and the newly submerged substrates are exposed to wave action.

The introduction of diversion discharges in addition to natural flows would change the discharge regime in the existing creek channels, with higher, longer duration discharges than those experienced in recent history. The change in discharge regime may induce a channel adaptation response consisting of changes to the channel width, depth and slope. Such changes could result in bank erosion, meander progression, and development of cutoffs, all of which would increase sediment availability and produce increases in sediment transport, deposition, and sediment concentrations.

The potential for channel erosion was assessed as a component of the Engineering Confirmation Study, where channel segments were classified according to erosion potential (Volume I: Appendix I). The management strategy proposed to mitigate the effects of channel erosion included enlargement of existing channels that were undersized and susceptible to erosion. Mobilization of unconsolidated or erodible sediments would likely occur predominantly during the initial period of commissioning and operation and it is expected that this effect would diminish shortly after commissioning. Over the long-term, erosion of the enhanced portions of the creek channels could occur during periods of higher than normal discharge (e.g., heavy rainfall events) or at locations of long-term instability. Sediment transport within a distinct section of creek would likely result in deposition in the nearest downstream reservoir or MUP, and sediment removal would be expected. Sediment removal would be more frequent in the early years of the SAWSP operation as the natural channels and constructed canals adapt to the diversion discharge. The frequency of removal would be expected to decrease as the system matures over time.

Diversion of Water from Red Deer River

Water quality modeling to assess the effects of diverting Red Deer River water to the SAWSP was first conducted in 1993. There have been three water quality modeling studies, and one series of updates to the water quality modeling completed (EMA 1993a and b; Golder 1998 and 2005). Throughout this period of assessment and design, there have been changes in the proposed irrigation demand, reservoir sizes, and the length and placement of diversion canals. These changes have been influenced by the results of different water quality modeling scenarios. Additional data required to refine and calibrate the model have been collected over the years. The additional data have resulted in more accurate predictions of the effects of diverting Red Deer River water to the Special Areas.

Use for Irrigation

Past water quality modelling studies have been primarily focused on accessing the potential for water diverted from the Red Deer River to be transported within the SAWSP system and maintained at a quality that would be sufficient to allow for irrigation use. The water quality parameters that serve as the primary indicators of suitability for irrigation are electrical conductivity (EC) and sodium adsorption ratio (SAR). Electrical conductivity (EC) serves as a measurable indicator of the total dissolved solids (TDS) concentration or salinity of water which affects the osmotic potential of soils and water uptake by plants. The SAR is a measure of the relative concentrations of sodium, calcium, and magnesium which reflects the sodicity or potential permeability of soil to water and air. The water diverted from the Red Deer River is considered to be of generally high quality with low EC and SAR concentrations relative to the Baseline Conditions in SAWSP watercourses (Volume IV: Water TBR) and the diversion is expected to result in a significant improvement in water quality within the Study Area, relative to existing conditions. The implications of these changes for aquatic biota have been discussed in the effects assessment sections for potentially affected VECs.

However, the mixing of diverted water with existing poor-quality surface and groundwater within the system could result in a degradation of water quality as water is transported through the SAWSP. Progressively increased salt concentrations could occur through the addition of salts from surface water runoff, near-surface groundwater influence, dissolution from newly saturated soils, as well as evaporative water losses and transpiration by plants (Golder 1995).

A surface runoff quality monitoring study was carried out to characterize baseline water quality conditions (Golder 2005). This allowed for calibration of the model to increase the accuracy of predicted salt loading from surface runoff sources. The results of field sampling and modeling were also used to identify the specific reservoirs and tributaries of Sounding Creek that had particularly poor baseline water quality (e.g., Antelope Lake and Picotte Creek) (Golder 2005). This allowed for the project to be modified to isolate these basins and avoid adverse effects on water quality. An example of this circumvention is the planned creation of a diversion canal to carry irrigation water to Oyen Tributary Reservoir, bypassing Picotte Creek and the receiving Sounding Creek Reservoir.

Likewise, soil diffusion testing was carried out to estimate the rate of salt release from bed sediments and increase the predictive capacity of the model (Golder 2005). This study identified high initial salt release through dissolution of minerals in weathered near-surface soils, followed by more gradual release and/or attainment of salinity equilibrium as less weathered soil minerals are slowly dissolved.

The most recent iteration of water quality modeling was conducted in Gold*Sim* using a project schematic that matched the Water Resources Management Model (WRMM) used to conduct hydrotechnical analyses (Golder 2005). A weekly water balance was generated using WRMM that accounted for inflows from diversion, surface runoff, and precipitation, as well as losses due to irrigation, stock watering, seepage, evaporation, and transpiration. The water balance data was input to Gold*Sim* to predict water quality at reservoirs/MUPs throughout the system based on runoff, bed flux, and mineral precipitation inputs and mass-loading over time.

The primary trend identified in the modeling reports is that the diversion of Red Deer River water to the system would reduce EC and SAR concentrations and create a more stable flow regime in both Berry and Sounding Creeks. The modeling studies found that diverted water transported through the system would be safe for irrigation most of the time, with exceedances typically occurring in the spring in association with spring flushing of accumulated salts in reservoirs, and in low flow periods during the fall. Water quality models predicted an increase in salinity downstream through the system due to the cumulative impacts of saline groundwater, surface runoff, and evaporation. Off-line reservoirs with historically poor water quality would receive minimal inflow of diverted Red Deer River water and were predicted to continue to have poor quality water that would be effectively isolated from the on-line system by bypass canals.

The Golder 1998 update to the water quality model compared wet versus dry years and its effects on salinity in the system. The EC and SAR levels were more stable during dry years, whereas wet years were more variable. Increased snowmelt improved water quality from January to March through dilution in the reservoirs, but increased spring surface runoff was predicted to carry high salt concentrations to the creeks which would degrade water quality. The comparison suggests that the diversion flows would have a greater positive impact on water quality during dry years when dilution would be more pronounced (Golder 1998).

Water quality modeling conducted in 2005 for the Initial Development scenario was representative of the current SAWSP layout and defined maximum diversion rate of 2.5 m^3/s (Golder 2005). The results of this study indicated that annual variation in EC and SAR is likely to occur with occasional, but infrequent exceedance of irrigation water quality guidelines occurring in the downstream portion of the Sounding Creek. Guideline exceedances would be expected to occur rarely in the upper portion of Sounding Creek or in Berry Creek and diversion of Red Deer River water to the SAWSP would typically result in safe irrigation water. The 95th percentile levels for EC and SAR were predicted to be below guideline thresholds for safe irrigation (Government of Alberta 2018b) in the on-line reservoirs 90% and 88% of the time, respectively (Golder 2005). Even during periods of infrequent exceedance, the predicted values for 95th percentile would remain below the threshold for "possibly safe" for irrigation, defined by the guidelines. Median values for EC and SAR were predicted to remain below these conservative guideline thresholds at all locations.

Use for Livestock Watering

Past water quality studies have focused on the use of diverted Red Deer River water for irrigation, and no modelling has specifically been conducted to predict the suitability of diverted water for livestock watering. There are no EC and SAR guidelines for livestock watering, but there are guidelines for TDS (Government of Alberta 2016 and 2018b). Background data from the Red Deer River indicated that TDS is typically low (Volume IV: Water TBR). For the Picotte water quality station, TDS analysis from the 2003-2007 runoff data shows a 7% exceedance rate of the 3,000 mg/L TDS guideline listed in the 2014 Alberta Environmental Quality Guidelines (Government of Alberta 2018b). The potential adverse influence of Picotte Creek would be mitigated by bypassing via the Oyen Tributary Reservoir. Given that Picotte Creek runoff represents relatively poor water quality conditions at baseline, TDS concentrations in surface water runoff from other sources contributing to Sounding Creek base flow would be expected to be of better quality. The TDS thresholds for irrigation use are conservatively lower than the threshold established for livestock watering. Using EC concentrations from the predictive modeling as a surrogate for TDS, salt concentrations within the SAWSP are typically expected to be low enough to comply with guideline thresholds for EC for irrigation use and would also likely be low enough to meet less conservative requirements for livestock watering. Given that livestock watering already occurs within the study area under Baseline Conditions, it is expected that the input of diversion water to the system would improve the quality of water available for livestock watering and result in a positive effect.

Use for Contact Recreation

Contact recreation use has been proposed for the enhanced Lehman Reservoir. The Oyen Tributary Reservoir could also potentially be used for recreational sport fishing but is not being considered as a contact recreation use site. The primary concern, in terms of water quality, for contact recreation is bacteria in the water. Fecal coliforms, and more specifically *Escherichia coli* bacteria, may cause illness in humans and must be evaluated to assess suitability for contact recreation use. The 2018 Alberta Environmental Quality Guidelines (Government of Alberta 2018b) have recreational guidelines for bacteria which state that the geometric mean over a 30-day period should not exceed

100 colony forming units (cfu)/100 mL and that no more than 10% of samples should exceed 320 cfu/100 mL over the same interval.

It is expected that livestock would continue to graze in the watershed of Lehman Reservoir. In addition, waterfowl and other wildlife would use and contribute to the bacteria load in the reservoir. Therefore, bacteria loading could be a concern for primary contact recreation, and to a lesser extent secondary contact recreation. The following section presents the *E. coli* sampling that occurred during the summer of 2014.

Because of Lehman's proposed contact recreation use, and the lack of *E. coli* data to evaluate existing conditions, Lehman Reservoir was sampled five different times over two sampling days in May and June 2014 (Table 1.6). The first sampling consisted of two samples on May 24, 2014. On June 21st, Lehman Reservoir was sampled again three times.

Table 1.6 Lehman Reservoir 2014 E. coli Sampling

Sampling Date	Sampling Point	E. coli (cfu/100mL)	Exceedance of Statistical Threshold Value of 320 cfu/100mL?
24-May-14	LEH-EC-1	20	NO
	LEH-EC-A	24	NO
21-Jun-14	LEHMAN E1	310	NO
	LEHMAN E2	290	NO
	LEHMAN E3	520	YES

While the sampling was not extensive, only once did the sample concentration exceed the statistical threshold value of 410 cfu/100 mL. Although the sample size and frequency were not large enough to constitute typical monitoring for contact recreation safety, the results did provide an indication that *E. coli* levels in Lehman Reservoir could be elevated under Baseline Conditions. In recognizing that sources of *E. coli* bacteria are finite and given the use of the land in the area, the primary sources of bacteria in the area are most likely livestock and wildlife. The daily climatic data collected in Coronation, Alberta suggested that there were rain events in the days leading up to both sampling dates. This may suggest the bacteria's source could be from overland runoff rather than direct deposition.

Given that Lehman reservoir would be the initial point of release for diverted water from the Red Deer River, it is likely that dilution and high replacement rates would limit the potential for runoff from local sources to cause elevation of *E. coli* concentrations above the safe threshold for recreation and that Lehman Reservoir would be safe for contact recreation use. However, this criterion has not been specifically considered in modelling conducted to date. If Lehman Reservoir is designated as a site for contact recreation, *E. coli* would be monitored during initial operation to confirm that water quality standards are being met, in accordance with AEP's typical monitoring process for reservoirs with potential for elevated *E. coli* concentrations.

Reduction of Water in the Red Deer River

Anticipated water withdrawal from the Red Deer River was evaluated using a WRMM simulation of the South Saskatchewan River Basin (SSRB) system in Alberta. The SSRB model considered available natural flows, full use of existing water licenses, apportionment requirements for Saskatchewan, and compliance with established water conservation objectives (WCOs) to assess the water potentially available to the SAWSP for the period 1928—2001. The model results suggest that the water supply in the Red Deer River is generally adequate to allow for diversion to meet the intended purposes of the SAWSP.

This assessment assumed that the SAWSP would be licensed within the management threshold that AEP has established for water allocation and that the SAWSP would be operated to meet the WCOs (Government of Alberta 2006). The AEP is responsible for allocating water use through issuance of water licenses under the provisions of the Alberta *Water Act* (R.S.A 2000, c. W-3). The WCOs have been established by AEP for the Red Deer River sub-basin through the SSRB Water Management Plan Government of Alberta 2006) as an administrative tool to promote increased flows. In defining WCOs for the Water Management Plan, AEP conducted consultation and considered technical studies that indicated that greater instream flows were needed to protect the aquatic environment than were afforded by past instream objectives (IO). As a result, AEP established the current WCOs to balance the needs of licensed water users with the requirements for instream flow during low flow periods associated with protection of the quality of the aquatic environment.

A technical study conducted by AEP developed an impact ratings methodology to assess the ecosystem effects associated with alternative water-use scenarios for the Red Deer River sub-basin (Goater *et al.* 2007). The study specifically assessed the potential for adverse effects on water quality under the current water management framework. The criteria used to assess water quality included water temperature, dissolved oxygen concentration, and ammonia assimilation. This assessment identified that under the current Water Management Plan (and assuming licensing of SAWSP and other predicted future uses) WCOs would frequently not be met. Senior licenses would not be subject to the same restrictions as newer licences, and water supply for newer licenses would be feasible only if the users relied on storage. A scenario where river water became limited was predicted to result in marginal increases in adverse effects on water quality due to increased duration and extent of dissolved oxygen guideline exceedance during the winter, potential for temperature guideline exceedances in the fall, ammonia exceedances in the spring, and increased aquatic weed growth. This assessment indicated that the SAWSP has the potential to contribute cumulatively to adverse effects on water quality under the current regulatory framework for water management in the Red Deer River sub-basin (Goater *et al.* 2007).

Ultimately, AEP is responsible for allocating water licenses and managing water use to balance water supply, economic development, and maintenance of the aquatic environment. Recommending changes in water management strategies or the regulatory framework to manage cumulative effects on the aquatic environment is beyond the scope of this assessment.

1.3.3.2 Mitigation Strategies and Best Practice Guidelines

Introduction of Deleterious Substances

AT requires a minimum standard of care for all construction contracts which includes standard mitigation measures to prevent spill or release of deleterious substances (Appendix I: Table I-2). It is expected that general effects of construction activities related to introduction of deleterious substances would be mitigated through implementation of standard methods employed on AT construction projects near water bodies (Appendices II-VI). Cast in place concrete would be allowed to cure for at least 48 hours before being exposed to water. Equipment would arrive at the site clean (no external mud, grease, oils) and free of leaks and mud and dirt should be removed from vehicles and equipment, including tracks and tires, to prevent the transfer of biota of concern (e.g., terrestrial and aquatic weeds and diseases).

Introduction of Methylated Mercury

With a decrease in the residence time of water, and conjecture regarding the establishment of recreational fishing in only two water bodies, mitigation for methylated mercury has not yet been developed. Should the SAWSP proceed to detailed design, and recreational fisheries be planned for one or two reservoirs, a detailed risk assessment would be required to determine the significance of the risk of the methylated mercury. Mitigations to reduce or control the risk would then be developed.

Erosion and Sedimentation

All AT construction projects are subject to standard mitigation measures for protection of the environment and these requirements are specified in the corresponding contract documents. In addition, AT regularly produces and updates guideline documents that provide direction to contractors on environmental requirements. The standard AT measures that would be incorporated into each of the contracts for the proposed SAWSP include the measures listed in AT’s Environmental Protection Plan (EPP) template document (Appendix II).

It is expected that general effects of construction activities related to introduction or mobilization of sediment in SAWSP water bodies would be mitigated through implementation of standard methods employed on AT construction projects near water bodies (Appendix I: Table I-2).

The potential for operational increases in sediment mobilization and transport within creek channels would be mitigated as identified in the Engineering Confirmation Study (ECS) (Volume I: Appendix I). This would include enlargement of Class 3 (Significant) channel segments to increase channel capacity to contain the design discharge, minimizing the process of channel adjustment predicted to occur if the channel were left to evolve naturally. Modified channel segments would be seeded to re-establish vegetation cover and willow staking or similar bioengineering solutions would be installed to increase roughness of banks. This would effectively reduce water velocity, extend bank stability, and enhance riparian habitat to increase local biodiversity. In addition, reaches of wide and shallow channel would be incorporated into the design to reduce flow velocity and to encourage emergent and semi-aquatic vegetation growth.

Diversion of Water from Red Deer River

Overall, the numerous water quality modeling studies have shown that diverting Red Deer River water to the Sounding and Berry Creek watersheds would improve water quality conditions and allow for suitable irrigation of the land. The planned system would circumvent water bodies that have been identified as containing particularly poor water quality including bypass canals at Craig Lake, Antelope Lake, Picotte Creek/Sounding Creek Reservoir, Esther Hay Meadow, and Grassy Island Lake. Isolating these off-line reservoirs has been included as a proposed mitigation measure that was specifically accounted for when conducting water quality modelling.

An additional mitigation measure that would be applied that would affect water quality of diverted water is the lining of canals to reduce seepage losses (Volume I: Appendix I). This mitigation is expected to reduce the potential for concentration of salts to occur, reducing the potential for water quality to be degraded below guideline thresholds.

As the project basis assumes that the SAWSP would be operated to meet the license requirements for water withdrawal during low flow periods stipulated by WCOs, no additional mitigation is expected to be required to meet the legislated requirements for protection of the aquatic environment related to water quality.

1.3.3.3 Assessment of Residual Effects

Based on the assessment of potential effects and application of mitigation measures, two residual effects were predicted and have been characterized in Table 1.7.

There is expected to be a positive residual effect of increased water quality throughout the Study Area because of the diversion of water from the Red Deer River. Water conveyed in the SAWSP is expected to be suitable for irrigation and livestock watering most of the time. Lehman Reservoir is expected to be suitable for contact recreation. However, it would be monitored to confirm compliance with guidelines. This effect is expected to be high in magnitude, regional in scale, and last the duration of the lifespan of the SAWSP. The effect would be considered significant.

The SAWSP maximum withdrawal rate of 2.5 m^3/s would be expected to occur primarily during periods of relatively high discharge when flow exceeds the needs of water users. During periods of low discharge, senior water license requirements and compliance with the WCO would limit the ability of the SAWSP to withdraw water from the Red Deer River. As such, the SAWSP is not expected to cause discharge to decrease below the legislated WCO. However, based on the AEP assessment of water-use effects on the aquatic environment (Goater et al. 2007), the SAWSP would likely contribute to withdrawal of water below the level deemed necessary for full protection of water quality, even when operating within the requirements of the current regulatory framework. Therefore, the SAWSP is predicted to have a residual effect on downstream water quality. Given that this effect would occur above the threshold established for protection of the aquatic environment by the current regulatory framework, the magnitude of the effect is low.

Table 1.7 Significance Characterization for Predicted Residual Effects on Water Quality after Mitigation

Project Activity	Predicted Effect	Direction	Magnitude	Geographic Extent	Duration	Reversibility	Significance
Diversion of water from the Red Deer River	Increase in water quality in the SAWSP Study Area including increased suitability for irrigation, livestock watering, and recreation	P	H	R	MT	ST	S
Diversion of water from the Red Deer River	Reduced water quality in the Red Deer River within the licensed requirements of the current regulatory framework	N	L	R	LT	ST	NS

1.3.3.4 Monitoring Requirements

An important component of the overall environmental monitoring activities and requirements would be monitoring of total suspended solids (TSS) levels during construction activities within the wetted perimeter of water bodies within the Study Area. Alberta Transporation has established specifications outlining the sampling methods, frequency, and compliance criteria for TSS monitoring, which is included in the contract for any project that may result in impacts to a water body. It would be the responsibility of the Contractor to ensure that *in situ* TSS monitoring is carried out in accordance with these specifications throughout construction, as required. The Contractor would be responsible for ensuring that the results of the TSS monitoring are reported to the construction manager (Consultant) and that potential concerns are addressed through modification of construction practices or environmental protection measures. Construction monitoring would be required to ensure that erosion and sedimentation are controlled within the construction footprint and that potential impacts to the aquatic environment are controlled.

Operational monitoring would be conducted to confirm the effects predictions regarding erosion and to establish where adaptive management may be required to mitigate documented effects. Specifically, annual inspections would be conducted for the first three years of operation to identify areas of active erosion within the creek channels, canals, reservoirs, lakes, and MUPs within the SAWSP system. Additional mitigation would be applied to stabilize areas of concern including installation of willow stakes or other bioengineered stabilization techniques that provide a natural long-term solution. It is expected that, after three years of monitoring, a downwards trend in erosion activity would have been noted, otherwise the monitoring program would need to be extended.

If Lehman Reservoir is designated as a site for contact recreation, *E. coli* would be monitored during initial operation to confirm that water quality standards are being met. This monitoring would be carried out following the standard processes that AEP employs at lakes and reservoirs that have the potential to develop water quality unsuitable for contact recreation. It is expected that the potential for unsuitable water quality for recreation to develop is low. However, if water quality monitoring indicates that *E. coli* concentrations in Lehman Reservoir are exceeding guideline thresholds, the reservoir may need to be closed to recreation until measures to reduce bacteria loading are implemented.

1.3.4 Surface Water Quantity

1.3.4.1 Potential Project Effects

The operation of the SAWSP would divert a higher volume of flow through the region relative to Baseline Conditions. However, the diversion would adhere to the WCO flow requirements as set by AEP. The proposed system would provide of a base flow (0.14 m^3/s) within ephemeral creek channels and would include water storage within many expanded reservoirs and MUPs.

From Lehman Reservoir, water would be released into Berry and Sounding Creeks and the Craig Lake Tributary. Water would be conveyed downstream through a system of natural creek channels, modified creek channels, canals, bypass canals, water storage reservoirs, and on-line and off-line MUPs. As much as practicable, water would be conveyed utilizing the existing creek channels as the primary conveyance system.

The system would utilize approximately 350 km of natural channels. This includes approximately 175 km on Sounding Creek, 29 km on the Craig Lake Tributary, 5 km on the Oyen Tributary and 141 km on Berry Creek. Some of the creek lengths included in these numbers would be submerged for at least part of the season by on-stream MUPs or the Diversion Reservoir.

Operation of the SAWSP could result in:

- changes in surface water quantity and duration of flow;
- loss of diversion water during conveyance;
- changes in creek channel morphology through erosion and scour; and
- changes in drainage patterns as a result of temporary and permanent physical works.

Change in Quantity and Duration of Flow

The introduction of diversion discharges in addition to natural flows would change the discharge regime in the existing creek channels, with higher, longer duration discharges than those experienced in recent history. Under natural conditions, peak discharges increase in the downstream direction as the catchment area increases. The diverted discharge, on the other hand, would decrease in the downstream direction as the water supplied at the upstream end is stored, consumed or lost along the route. The change in creek channel wetted surface area would be dependent upon channel morphology and has not been quantified. Given that baseline discharge is typically negligible, the increase in quantity and duration of surface water discharge in the creek channels is expected to lead to positive effects on: irrigation and stock watering land uses; socio-economic conditions; aquatic, wetland and riparian habitat and resident fish and wildlife species; and surface and groundwater quality.

Water storage capacity in most reservoirs and MUPs would be increased to provide operational storage benefits and enhanced wetland/wildlife habitat conditions relative to existing conditions. The predicted change in surface area at water bodies within the Study Area is summarized in Table 1.8. The total surface area of water bodies affected by the SAWSP is predicted to increase from approximately 2500 ha at the peak flooded extent at baseline to approximately 4300 ha at the proposed design FSL. This represents an increase of approximately 1800 ha, an increase of over 70% from baseline. In addition to this change in peak operating surface area, operation is expected to result in greater water permanence through the provision of a base flow through the system, and controlled drawdown of the MUPs to mimic the natural hydrologic cycle. Diversion would provide a more reliable water source, relative to the baseline condition, but would still be subject to the effects of drought in low discharge years.

Diversion of water from the Red Deer River to supply the SAWSP would result in a decrease in surface water quantity relative to the baseline condition of the river. Localized decreases in discharge would likely occur within sections of bypassed creek channel. These effects are discussed in more detail in the SAWSP component specific assessment sections.

Diversion Water Losses

The expected volumes of water entering and leaving the SAWSP system during an average year are summarized in Table 1.9. Local inflows would supplement the water diverted from the Red Deer River, supplying approximately 30% of the system water requirements on average. Water would be consumed or lost in a variety of ways (Table 1.9). Irrigation is expected for approximately 3,240 ha of land that has been identified as suitable for irrigation (Hecker 1995). Evaporation losses would occur from reservoirs, MUPs, and creek and canal surfaces. Domestic use and stockwatering would be relatively small and are accounted with conveyance losses consisting of channel priming losses, seepage and evapotranspiration from shoreline vegetation. Backflood irrigation represents the water that would be used to saturate the land within the FSL of the MUPs during filling each spring. Downstream release includes discharge to Carolside Reservoir and Sounding Lake. Minimum channel flows would be maintained throughout the system to reduce priming and recharge losses as well as response time for meeting demands when required.

Table 1.8 Change in Water Surface Area

Project Component	Impact Description	Baseline FLS (ha)	Design FSL (ha)	Change in Wetted Area (ha)	% Change in Wetted Area
Lehman Reservoir	Reservoir Footprint	134.7	649.2	514.5	282%
	Diversion Canals	0.0	15.8	15.8	N/A
Oyen Tributary System	Diversion Reservoir Footprint	8.6	89.8	81.2	944%
	Oyen Tributary Reservoir Footprint	50.3	395.4	345.1	686%
	Oyen Inlet Canal	0.0	17.0	17.0	N/A
	Sounding Creek Reservoir	159.2	145	-14.2	-9%
Craig Lake Bypass Canal	Canal footprint	0.0	7.1	7.1	N/A
Scaupshovel Bypass Canal	Canal footprint	0.0	3.7	3.7	N/A
	Diversion headpond	0.8	4.0	3.2	400%
Antelope Lake Bypass Canal	Canal footprint	0	7.2	7.2	N/A
	Diversion headpond	8.8	45.1	36.3	413%
Esther Hay Meadow Bypass Canal	Canal footprint	0.0	23.9	23.9	N/A
	Diversion headpond	0.2	2.0	1.8	900%
BC-4 Fertility	MUP footprint	14.0	104.6	90.6	647%
BC-5 Dale	MUP footprint	21.8	40.4	18.6	85%
BC-7 Contracosta	MUP footprint	538.7	631.7	93.0	17%
BC-8 Richdale	MUP footprint	26.5	45.2	18.7	71%
SO-5-6 Motz	MUP footprint	59.1	73.6	14.5	25%
SO-7 Mitchell	MUP footprint	40.5	43.8	3.3	8%
SO-10 Wingding	MUP footprint	43.7	47.1	3.4	8%
SO-11 Scaupshovel	MUP footprint	61.6	106	44.4	72%
SO-39 Esther Hay Meadow	MUP footprint	585.6	862.7	277.1	47%
CR-6 Craig Lake	MUP footprint	515.5	625.3	109.8	21%
CR-8 Sneath	MUP footprint	47.5	48.6	1.1	2%
CR-10 Peter	MUP footprint	30.5	32.5	2.0	7%
CR-13 Loon Slough	MUP footprint	81.4	118.6	37.2	46%
CR-14 Scoville	MUP footprint	27.4	73.9	46.5	170%
	Totals	**2456.4**	**4259.2**	**1802.8**	**73%**

Table 1.9 SAWSP Mean Annual Water Balance

Water Balance Item	Annual Volume ($M\ m^3$)
Inflows	
Diversion from the Red Deer River	31.8
Local Inflow	13.0
Total	**44.9**
Outflows	
Irrigation	11.2
Reservoir Evaporation	3.3
MUP Evaporation	7.4
Channel Evaporation	1.9
Domestic Use, Stockwatering and Conveyance Losses	6.3
Backflood Recharge	2.6
Downstream Release	12.0
Total	**44.9**

Channel Morphology and Erosion

The change in discharge regime may induce a channel adaptation response consisting of changes to the channel width, depth and slope. Such changes could result in bank erosion, meander progression, and development of cutoffs, all of which would increase sediment availability and produce increases in sediment transport, deposition, and sediment concentrations.

KCB conducted a creek channel assessment to determine the potential level of impact to channel reaches throughout the SAWSP. After analysis, potential impacts to channel reaches along Berry Creek, Sounding Creek, and Craig Lake Tributary were designated as either significant, moderate, or minor, as described below.

Significant (Class 3) Channel Modification

- Increases in channel capacity are required in order to contain the design discharge within the channel, and to reduce the amount of erosion as the channel adjusts to its new dominant discharge.
- The channel is expected to adjust to the new discharge naturally over time without intervention. However, left to natural processes, changes to the morphology of the creeks would not be controlled.

Moderate (Class 2) Channel Modification

- In these reaches, it is possible that little or no erosion would occur, but it is also possible that some erosion would occur due to increases in discharge duration even though the design discharge is less than the dominant discharge.

Minor (Class 1) Channel Modification

- No erosion expected; some sedimentation may occur.

Designated impact levels for the analyzed reaches of the three stream channels and proposed mitigative measures are provided in Table 1.10.

Table 1.10 Creek Channel Impacts Along Assessed Reaches

Reach	Impact Level	Reaches Within Specific System[1]		Comment[2]
		From (km)	To (km)	
Upper Sounding Creek				
S1	Moderate (Class 2)	0.0	12.0	Creek Channel
		1.2	4.0	Numerous small channels along the floodplain could develop into meander cutoffs. **That development should be prevented by blocking the upstream ends of the small channels with earth plugs, some with culverts to allow limited flow.**
		12.0	16.9	Motz MUP (SO-5/6)
S2	Moderate (Class 2)	16.9	19.0	Creek Channel
		19.0	25.3	Mitchell MUP (SO-7)
S3	Significant (Class 3)	25.3	30.5	**Creek Channel to be modified**
		30.5	35.6	Wingding MUP (SO-10)
S4	Significant (Class 3)	35.6	41.3	**Creek Channel to be modified**
		41.3	45.7	Scaupshovel Bypass Canal
	Minor or None (Class 1 or Nil)	45.7	47.2	Creek channel carrying only spill from Scaupshovel MUP
S5	Significant (Class 3)	47.2	60.8	**Creek Channel to be modified**
		48.0		Creek obstruction causing flooding west of the channel
		60.8	66.0	Reach with multiple active channels
		66.0	68.8	Antelope Lake Bypass Canal Diversion Pond
		68.8	79.4	Antelope Lake Bypass Canal
S6	Significant (Class 3)	79.4	82.4	Dam and reservoir
		82.4	86.0	**Creek Channel to be modified**
S7	Minor or None (Class 1 or Nil)	86.0	97.5	Creek Channel
		97.5		Dam (possibly decommissioned)
S8	Moderate (Class 2)	97.5	107.5	Creek Channel
		100.2		Dam
		101.8	102.9	Dam and reservoir
		104.0	107.5	Dam and reservoir
Oyen Tributary to Sounding Creek				
Not Identified in KCB (2015)	Significant (Class 3)	13.7 of Oyen Tributary System	20 of Oyen Tributary System	**Creek Channel to be modified**

Reach	Impact Level	Reaches Within Specific System[1]		Comment[2]
		From (km)	To (km)	
Lower Sounding Creek				
Not Identified in KCB (2015)	Minor or None (Class 1 or Nil)	107	290.5	Creek channel
		290.5	295	Esther Hay Meadow MUP (S0-39)
		295	312	Grassy Island Lake
		312	315.9	Creek Channel
		315.9	317.5	Berry Lake
		317.5	325	Creek Channel
		325	332.5	Pemukan Flats
		332.5	371	Creek Channel
		371		Sounding Lake
Craig Lake Tributary				
C1	Moderate (Class 2)	1.6		Craig Lake Canal enters
		1.6	3.6	The flow path consists of three connected ponds and a few hundred metres of poorly defined channel **which may require enlargement**.
		3.5	6.4	Sneath MUP (CR-8)
C2	Significant (Class 3)	6.4	6.5	**Creek Channel to be modified**
		6.5	10.6	Peter MUP (CR-10)
C3	Moderate (Class 2)	10.6	24.8	Creek channel
		17.5	21.6	Loon Slough MUP (CR-13)
		18.6	19.2	No defined channel
		21.6	24.8	Scoville MUP (CR-14)
		24.8	26.5	Scaupshovel MUP (SO-11)
C4	Minor or None (Class 1 or Nil)	26.5	31.2	Scaupshovel MUP (SO-11)
Berry Creek				
B1	Minor or None (Class 1 or Nil)	10.6	17.0	Creek channel
		17.0	23.4	Dale MUP (BC-5)
B2		23.4	50	Creek Channel
		51	53	Contracosta MUP (BC-7)
B3		53	72	Creek Channel
		72	78	Richdale MUP (BC-8)
B4		75	141	Creek Channel
		141		Carolside Reservoir

Notes:
[1] Refer to Digital Map Package
[2] Bold font indicates channel modifications would be expected

Disruption of Drainage Patterns

Construction and operation of the SAWSP has the potential to affect drainage patterns over both the short- and long-term. Temporary effects on drainage could occur as a result of activities to construct SAWSP infrastructure, as well as temporary access routes and laydown areas. Likewise, inadequate surface water management during construction could lead to erosion and sedimentation within the work areas or natural drainage pathways.

The WRMM simulation of the SAWSP operating conditions accounted for inflows from surface runoff within the drainage basin based on the effective catchment area and assumed that all drainage would continue to be concentrated within the natural drainage basin. Given that the SAWSP is designed to convey water within the natural drainage basin, regional changes in surface water drainage pathways are not anticipated. Operational effects on drainage are primarily expected to include increased quantity and duration of discharge resulting from diversion but could also include localized effects on discharge as a result of disrupted overland drainage patterns, diversion of existing flow pathways, and watercourse crossings. Local effects on drainage patterns are identified and discussed in the respective SAWSP component specific assessments.

Boat Use

Within the SAWSP region, the Red Deer River is the one watercourse that can be navigated by boat. The creeks within the in-basin distribution system are ephemeral in nature and do not support navigation.

1.3.4.2 Mitigation Strategies and Best Practice Guidelines

Water Conservation

Specific measures have been considered to mitigate the loss of diversion water conveyed within the system (Appendix I: Table I-3). As described in Volume I: Section 2.1.6 (Project Alternatives and Design Evolution) the SAWSP has evolved throughout the design process in response to analysis of water balance. A pipeline has been identified for the WSS primarily to reduce conveyance losses from evaporation, evapotranspiration, and seepage. The excavated bypass canals within the in-basin distribution system represent a greater potential for seepage losses and it has been assumed that portions of these canals would be lined as a result.

Channel Modification and Erosion Protection

Increases in water levels and longer duration of water presence in the creek channels are expected to result in an increase in riparian vegetation in the SAWSP creek channels. Therefore, the management of increased water levels and flow would be done with bioengineered solutions that enhance or expedite naturally occurring processes.

Where impacts to the existing creek structure or containment capacity are predicted, mitigation strategies are proposed (Appendix I: Table I-3). Mitigation measures for the three categories of potential impacts are recommended as discussed below.

Significant (Class 3) Channel Modification

Mitigation measures:

- Reduce the amount of sediment movement associated with the adjustment by the enlargement of the channel.
- Introduce willow staking or similar bioengineering solutions to increase roughness of banks. Water velocity can be reduced, bank stability can be extended, and riparian habitat can immediately enhanced to increase local biodiversity.
- Include reaches of wide and shallow channel design to reduce flow velocity and to encourage emergent and semi-aquatic vegetation growth.

Moderate (Class 2) Channel Modification

Mitigation measures:

- monitor the performance of these reaches after the SAWSP is in operation, and address erosion issues that occur at that time; and
- introduce willow staking to protect erosion-prone locations to help preserve bank stabilization and provide additional habitat to enhance local biodiversity.

Minor (Class 1) Channel Modification

Mitigation measures:

- no mitigation measures are expected to be necessary; and
- the channels should be monitored to confirm that channel erosion does not occur.

The reliance of natural systems or the use of bioengineered solutions to control the designed discharge in reaches predicted to be significantly affected would be the first consideration. The use of naturalized design would be considered an option where problem locations are biologically suitable and practical for the inclusion of a bioengineered design.

Bioengineering

At a minimum, where the channel design requires the removal and replacement of soils, graminoid seeding would be used to stabilize soil exposed during construction. It is anticipated that over the longer-term, permanent riparian vegetation would become established along many of the reaches due to increased water availability. Riparian vegetation is most likely to become established where relatively slower and shallow water flows occur naturally. As noted above, bioengineering solutions, such as willow staking, would expedite the establishment of later-stage succession vegetation. The introduction of woody vegetation, such as willows, along the outside banks of meanders would help protect bank stability and reduce erosion. As the willows grow and mature, the biodiversity associated with the riparian habitat would increase relative to areas without riparian vegetation. Riparian willow shrub habitat would be suitable nesting and foraging habitat and provide protective and thermal cover for numerous birds and mammal species. Temporary fencing would be required to protect the new vegetation from grazing cattle.

The inclusion of wide and shallow channel reaches in the SAWSP design would also assist in water control and promote the presence and growth of riparian vegetation. Areas of slow moving, shallow water may provide the opportunity for emergent and semi-aquatic vegetation to become established. The presence of submerged and emergent vegetation would provide breeding habitat for forage fish, amphibians, and odonates. Emergent and stream-side vegetation would provide habitat for aquatic and semi-aquatic bird and mammal species. In addition, the establishment of emergent vegetation would provide a natural impediment to sediment transport.

Structural Controls

Structural controls such as drop structures were considered in previous work. Based on the results of the current assessment, drop structures are unlikely to be required, as the changes in channel slope are minor.

Sediment Traps

Sediment traps were also considered in previous work. Considering that many of the channel reaches are believed to be oversized and therefore expected to reduce in width and depth through sedimentation and considering the available sediment storage capacity in natural pools within the channel and within constructed storages such as MUPs, it is currently believed that few if any sediment traps would be required. The need for sediment traps should be evaluated during initial years of operation. If required, sediment traps should be located immediately upstream of MUPs or bypass canals.

Surface Water Management

Surface water management during the construction period would be expected to follow the mitigation measures and best practices laid out in the EPP and the Contractor’s ECO Plan to reduce the potential for effects on surface water quantity or drainage patterns (Appendices II and III). This would include establishing temporary measures to control surface water runoff within active construction areas, installing culverts and ditches to pass flow at temporary barriers such as roads, and strategically locating access roads and temporary work spaces to avoid areas of concentrated water movement or storage. Likewise, standards for erosion and sediment control (ESC) (Appendix VI) are incorporated into contract documents and would be closely evaluated during contract administration.

It is expected that general effects of construction activities related to surface water management and sedimentation would be mitigated through implementation of standard methods employed on all AT construction projects near water bodies (Appendix I: Table I-3).

1.3.5 Ground Water Quality and Quantity

1.3.5.1 Potential Project Effects

Groundwater conditions are variable throughout the SAWSP region and are influenced by topography and existing drainage patterns. As previously stated, operation of the SAWSP would divert a much higher volume of surface water flow through the LSA than the baseline condition, including expanded water storage within reservoirs and MUPs and provision of a base flow within online creek channels. Increased streamflow and water storage across the SAWSP is expected to increase groundwater recharge within the vicinity of these components. Increased recharge would result increases in groundwater elevations in areas immediately adjacent to these project components. The potential impacts of elevated groundwater levels include:

- increased seepage from ground surfaces such as valley sides, low lying areas, and ephemeral watercourses; and
- increased discharge to permanent water bodies, streams, and rivers as base flow.

Given that the water conveyance infrastructure would be located within the lowest elevation natural drainage paths of an area characterized by low-relief topography, the potential for increased groundwater recharge from reservoirs and channels to result in seepage and surface discharge is considered to be low. In general, water loss from surface water bodies would likely be greatest in spring as discharge increases and the system is primed, but seepage would be expected to be reduced as near-surface groundwater aquifers become saturated. Saturation would ultimately lead to reduced rates of absorption of surface water derived from diversion or natural runoff and concentration of surface water in the water bodies that make up the SAWSP. Increased water retention in local low-lying depressions may increase vegetation production and wetland function, but this effect would likely be negligible. No effects on crop productivity are anticipated as crops do not occur in low-lying areas that could potentially be influenced.

Reservoirs and MUPs

An increase in surface area and depth at FSL is likely to increase groundwater recharge within the vicinity of reservoirs and MUPs. Increased recharge would result increases in groundwater elevations which would be dissipated as groundwater flows radially from reservoirs and MUPs. In areas where clay till dominates the surficial geology, increased groundwater levels are expected to be dissipated over relatively short distances away from the FSL contour. Given the water being conveyed by the SAWSP would be of higher quality, the recharge of water would be positive. This effect is expected to be local in extent and would fluctuate regularly as reservoirs and MUPs are filled and drawn down, continuing for the operational existence of the SAWSP

Existing Creek Channels

The increased flow volume and addition of a base flow in channels utilized by the SAWSP would increase local groundwater recharge in these areas. Groundwater levels in shallow aquifers close to creek channels would increase, but overall the impact is expected to be negligible.

In areas where water diverted for the SAWSP would be routed around existing water bodies or creek channels via by-pass canals, decreased flow volume may decrease local groundwater discharge. Groundwater levels in shallow aquifers close to abandoned creek channels would decrease, but overall the effect on groundwater is expected to be local and negligible.

Canal Seepage

Significant increases in seepage or spring flow would be expected if sand and gravel aquifers are in hydraulic connection with the canals within the proposed alignments. Seepage reduction measures such as impervious earth liners or plastic geomembrane liners may be required in some areas to reduce canal seepage. The installation of a liner over known sand and gravel deposits in the canal alignments would preclude direct hydraulic connection. Liners may consist of single-bank (i.e. low side) or full-section liners (impervious fill or geomembrane liners covered by gravel armour). No effect to groundwater would be expected after mitigation.

Groundwater Quality

Increased interaction between surface water and groundwater resources as a result of increased recharge has the potential to affect groundwater quality. As discussed in Section 1.2.4.2, surface water quality within the reservoirs and creek channels of the SAWSP is expected to increase due to the diversion of water from the Red Deer River of a higher quality than the surface water that occurs under Baseline Conditions. Regional groundwater quality is varied but is generally characterized by high concentrations of TDS, sulfates, and other major cations and anions (Volume I: Appendix I). In Special Areas 2, 3 and 4, the groundwater from the surficial deposits are mainly Ca-Mg-HCO3 with some Na-HCO3 type waters. Most of the groundwater in the bedrock aquifers in Special Areas 2, 3, and 4 are Na-HCO3 or Na-SO4 type waters (Volume I: Appendix I). Approximately 60 % of the groundwater samples from surficial deposits reported TDS concentrations of greater than 1000 mg/L, with TDS concentrations less than 500 mg/L occurring mainly in the western part of Special Area 2 and eastern part of the Special Area 3 (Volume I: Appendix I). TDS concentrations in bedrock groundwater in Special Areas 2, 3, and 4 range from 500 to 3000 mg/L, with TDS concentration greater than 3000 mg/L occurring mainly in the north and eastern areas of Special Area 3 and southwest area of Special Area 4. Nitrate and Nitrite concentrations in surficial groundwater samples exceed the Guidelines for Canadian Drinking Water Quality maximum acceptable concentration (10 mg/L) mainly in the northeast area of Special Area 2, the north area of Special Area 3 and in the east/northeast area of Special Area 4 (HCl 2000).

Water diverted from the Red Deer River is expected to contain relatively low concentrations of dissolved solids, based on historical sampling. Increased groundwater recharge is therefore expected to result in a positive effect on groundwater quality during typical operations.

Surface water interactions with groundwater have the potential to introduce deleterious substances in the unlikely event of a release of chemicals required during construction and/or operation and maintenance (e.g., gasoline or diesel fuel for vehicles and equipment, solvents, hazardous materials or wastes). The primary pathway for potential groundwater contamination is infiltration from surface into layers of sand within the clay tills found along some areas of the canal alignments. Groundwater flow through these layers could potentially dissipate groundwater contamination beyond the initial source point; however, the potential for introduction of deleterious substances into the local groundwater is expected to be negligible and can be controlled through the application of standard mitigation measures.

Conflicts with Other Groundwater Users

The Water TBR (Volume IV) included a search of water well drilling reports on file with AEP for water wells located within 1.6 km of the SAWSP footprint. The spatial distribution of wells located within the search radius is included in the (Digital Map Package). Wells in the vicinity of the SAWSP included wells drilled for co-ops and colonies, de-watering, domestic, stock, industrial, investigation, monitoring, municipal, and observation uses, and a number of wells with unknown use.

As discussed in the previous sections, an overall increase in both the quantity and quality of local groundwater is expected in the vicinity of the SAWSP. Therefore, conflicts with other groundwater users in the vicinity of the SAWSP would not be anticipated.

1.3.5.2 Mitigation Strategies and Best Practice Guidelines

Groundwater Quantity and Seepage

The impacts to groundwater quantity resulting from the SAWSP are expected to be low magnitude, local, and neutral in direction (Appendix I: Table I-4). Seepage reduction measures such as impervious earth liners or plastic geomembrane liners may be required in some areas along the proposed canal alignments to reduce surface water loss through canal seepage, which would in turn reduce the magnitude of effect on groundwater quantity. Likewise, specific measures may be included to control seepage at dam embankments. Further mitigation measures may be required in the future if impacts on groundwater levels or seepage are detected through monitoring.

Groundwater Quality

AT requires a minimum standard of care for all construction contracts which includes standard mitigation measures to prevent spill or release of deleterious substances. It is expected that general effects of construction activities related to introduction of deleterious substances would be mitigated through implementation of standard methods employed on all AT construction projects near water bodies (Appendices II-VI). Rapid response and clean-up of a spill would reduce the potential for the release to interact with and contaminate near-surface groundwater.

Conflicts with other Groundwater Users

Conflicts with other groundwater users are not anticipated; therefore, no mitigation is proposed.

1.3.5.3 Monitoring Requirements

A groundwater monitoring program would be conducted to monitor changes in groundwater levels in response to the SAWSP, to confirm the conclusions regarding residual groundwater effects. The monitoring program would include visual inspection of potential seepage areas. Monitoring would also be carried out at dam embankments to confirm that mitigation measures have been effective in controlling seepage.

1.3.6 Fish and Aquatic Habitat

Potential Project Effects

Potential effects of the SAWSP on fish and aquatic habitat include:

- change in habitat quantity;
- change in habitat suitability and accessibility;
- change in fish community species composition;
- sedimentation;
- introduction of deleterious substances causing acute or chronic toxic effects; and
- direct fish mortality and stranding.

Change in Habitat Quantity

The SAWSP may cause changes in aquatic habitat quantity through construction of infrastructure such as dam embankments which cause physical displacement of habitat or changes in operation that alter the surface area of water bodies within the Study Area. The net SAWSP effect on habitat quantity associated with specific components is summarized in Table 1.11.

In general, operation of the SAWSP would divert a much higher volume of flow through the region than baseline conditions and would include water storage within many expanded reservoirs and MUPs and provision of a base flow (0.14 m^3/s) within online creek channels. Project infrastructure such as dam embankments, outlet structures, and spillway channels that encroach upon existing habitat are necessary to provide increased water storage capacity and would be balanced by the resulting gains in habitat area. Based on the current design, the SAWSP is expected to result in a large net gain of 1517.5 ha of permanent aquatic habitat distributed throughout the Study Area at reservoirs and MUPs. The only identified reduction in permanent habitat quantity occurred at Sounding Creek Reservoir. Permanent habitat included areas expected to support year-round residence of fish including directly connected habitats (e.g., the entire surface area of a reservoir at FSL). Temporary, adverse effects on habitat included seasonally dewatered habitat that posed a potential risk of stranding fish within unsuitable habitat (e.g., creek channels and canals). The quantified net change in temporary or seasonal habitat accounted for transition of creek habitat within expanded reservoir footprints, physical displacement of habitat, abandonment of channel segments as a result of diversion, creation of new channels, and expansion of temporary habitat in existing seasonally suitable MUPs. The SAWSP is predicted to result in a net increase of 177.8 ha of temporary aquatic habitat.

Table 1.11 Summary of Change in Aquatic Habitat Quantity associated with SAWSP

Project Component	Impact Description	Area flooded at baseline (ha)	Design FSL (ha)	Change in Temporary Habitat (ha)	Change in Permanent Habitat (ha)
Main Supply System	Intake Basin				0.1
Lehman Reservoir	Reservoir Footprint	134.7	649.2	-40.5	555.0
	Dam Embankment			-0.5	
	Diversion Canals			15.8	
Oyen Tributary System	Diversion Reservoir Footprint	8.6	89.8	-8.4	89.8
	Diversion Reservoir Dam Embankment			-0.1	
	Oyen Tributary Reservoir Footprint	50.3	395.4		345.1
	Oyen Inlet Canal			17.0	
	Sounding Creek Reservoir	159.2	145		-14.2
Craig Lake Bypass Canal	Canal footprint	0	7.1	7.1	
Scaupshovel Bypass Canal	Canal footprint	0	3.7	3.7	
	Diversion headpond	0.8	4	3.2	
Antelope Lake Bypass Canal	Canal footprint	14.4	7.2	-7.2	
	Diversion headpond	8.8	45.1	36.3	
Esther Hay Meadow Bypass Canal	Canal footprint	31.8	23.9	-7.9	
	Diversion headpond	0.2	2	1.8	
BC-4 Fertility	MUP footprint	14	104.6	-14.0	104.6
	Dam Embankment			-0.7	
BC-5 Dale	MUP footprint	21.8	40.4	-3.7	22.3
	Dam Embankment			-0.1	
BC-7 Contracosta	MUP footprint	538.7	631.7	93.0	
	Dam Embankment			-0.3	
BC-8 Richdale	MUP footprint	26.5	45.2		18.7
SO-5-6 Motz	MUP footprint	59.1	73.6		14.5
	Dam Embankment			-0.1	
SO-7 Mitchell	MUP footprint	40.5	43.8		3.3
	Dam Embankment			-1.4	
SO-10 Wingding	MUP footprint	43.7	47.1		3.4
	Dam Embankment			-0.3	
SO-11 Scaupshovel	MUP footprint	61.6	106	-61.6	106.0
	Dam Embankment			-0.2	
SO-39 Esther Hay Meadow	MUP footprint	585.6	862.7	277.1	
	Dam Embankment			-0.4	
CR-6 Craig Lake	MUP footprint	515.5	625.3	109.8	
CR-8 Sneath	MUP footprint	47.5	48.6	-47.5	48.6
	Dam Embankment			-0.4	
CR-10 Peter	MUP footprint	30.5	32.5	-30.5	32.5
	Dam Embankment			-0.1	
CR-13 Loon Slough	MUP footprint	81.4	118.6	-81.4	118.6
	Dam Embankment			-0.5	
CR-14 Scoville	MUP footprint	27.4	73.9	-27.4	73.9
	Dam Embankment			-0.1	
			Net Change	**229.6**	**1522.2**

Change in Habitat Suitability and Accessibility

Diversion of water from the Red Deer River to the SAWSP Study Area would greatly increase the quantity of water available to and stored within the Berry Creek and Sounding Creek systems. Typically, discharge is confined to a short period of snowmelt runoff in the spring followed by intermittent discharge as a result of rain events. The SAWSP proposes to divert water to provide a minimum base flow and sufficient storage to meet projected irrigation demands and enhance aquatic habitats. Increasing the depth of reservoirs and MUPs and providing a more reliable source of water would result in an increase in the number and overall suitability of permanent habitats within the Study Area. The proposed operating regime for MUPs would mimic the natural hydrologic regime, using automated control structures to slowly drawdown reservoir surface area over the course of the open water season. The increased extent and duration of inundation and reduced variability is expected to increase habitat suitability. Transition of seasonally suitable creek habitat, which represents impounded habitat under typical conditions, to permanent reservoir habitat is considered to be an improvement in habitat suitability as a result of reduced stranding potential. Although creek channel habitats would continue to be seasonal in nature and would be dewatered at the end of the irrigation season, the suitability of this seasonal habitat would be increased as a result of a substantially increased duration of flow. A minimum base flow of 0.14 m^3/s would be maintained in primary creek channels, as water availability allows, through the entire operating season (April 9 to October 21).

Operation of the SAWSP is also expected to increase aquatic habitat suitability as a result of improved water quality. As discussed in Section 1.3.3, the SAWSP is expected to result in a general improvement in water quality during operation, including reduced occurrence of water quality guideline exceedances. Water diverted from the Red Deer River is expected to contain lower concentrations of solutes than would be expected to occur within the SAWSP water bodies under Baseline Conditions. Increased duration of flow and reduced effects of evapoconcentration would further reduce the potential for developing high salinity or otherwise impaired water quality conditions. Likewise, increased duration of flow and water permanence would reduce the potential for water temperature and dissolved oxygen conditions to develop that would be unsuitable for resident species, year-round. Improved water quality would potentially allow for resident fish species to disperse to or more frequently occupy habitats that had been previously unsuitable (e.g., Craig Lake), may increase benthic invertebrate species diversity and abundance, and would provide increased temporal availability of seasonally suitable habitats.

The increase in FSL water elevation at reservoirs and MUPs may also affect physical habitat characteristics such as substrate composition, littoral and riparian vegetation species composition and abundance, and water quality, which may in turn affect habitat suitability for aquatic invertebrate and fish populations. In addition, changes in aquatic invertebrate populations may affect fish.

The inundated littoral area at the new FSL would be subjected to the same erosive wave action that created the existing reservoir bottom from flooded prairie. It is expected that terrestrial vegetation within the inundation zone would gradually break down and that the underlying soils would be exposed, forming a similar substrate of fine sediments to that of the existing reservoir bottom. An anticipated change in substrate composition would be associated with armouring of infrastructure. In the case of dams and reservoir outlet infrastructure, the small proportion of reservoir area armoured would increase proportionately to the perimeter of the reservoir as the dam footprint increases. Canals represent new seasonal habitat that would be armoured with gravel to minimize erosion, providing substrate of a relatively uncommon type, and would likely support less vegetation establishment as compared to natural channel segments.

Increasing FSL is expected to result in a loss of existing emergent vegetation which would likely become re-established at an equal or greater extent at the perimeter of the reservoir at the new FSL. An increase in depth in the reservoir at the new FSL would result in a shift in the functional euphotic zone and a shift in the location of rooted submerged macrophyte species. However, increasing the FSL would result in a proportional increase in the potential littoral zone surface area, relative to the Baseline Conditions and an increase in the extent of both emergent and submerged aquatic vegetation.

The vegetation cover within the riparian zone adjacent to existing reservoirs and MUPs was typically dominated by grazed prairie grass species with limited occurrence of wetland or transitional species dependent upon increased water availability. Inundation of the existing riparian area would result in a loss of the existing riparian vegetation. However, increasing the reservoir surface area would increase the perimeter of the reservoir available for colonization by riparian species proportionately. Furthermore, increased duration of inundation, gradual drawdown, and reduced seasonal variability would provide more suitable conditions for establishment of riparian and transitional wetland vegetation species. Raising the FSL is expected to result in a short-term reduction in the occurrence of transitional riparian species, followed by a long-term increase in riparian habitat area.

Benthic (bottom dwelling) invertebrate samples collected from reservoirs and seasonal creek habitat within the Study Area indicated relatively sparse abundance and low species richness of invertebrates. Raising reservoir levels would necessitate that the existing population of benthic invertebrates move to higher elevations to establish within the shifted littoral zone. However, the increased surface area would result in a proportionate increase in the area of littoral habitat available for colonization by benthic invertebrates. Increased seasonal permanence of water and water quality could also result increased habitat suitability for benthic invertebrates. Increased reservoir surface area and water quality is also expected to have a positive effect on phytoplankton and zooplankton, which occupy the euphotic portion of the water column. Increasing benthic and planktonic productivity would in turn have a positive effect on brook stickleback and fathead minnow populations as a result of increased quality and availability of food. However, the concentration of solutes in solonetzic soils in some inundated locations could lead to a decline in suitable conditions that would support growth of macrophytes and invertebrates, at least over the short-term. The soils would be erodible and a period of flux, during which solute concentrations in surficial materials would be reduced through leaching or direct erosion, would be expected. In general, the effect could lead to initially low benthic productivity. Given that benthic populations are relatively limited in reservoirs under existing conditions at baseline, the net difference in productivity would not be significant.

Access would continue to be impeded by permanent barriers at dam structures, but access to seasonally available habitat in creek channel segments upstream of reservoirs and MUPs is expected to increase as a result of increased quantity and duration of flow. In addition, the incidence of temporary barriers to fish passage and resulting habitat fragmentation is expected to decrease because informal or undersized crossing structures, water impoundment structures, and beaver dams would be removed to promote hydraulic connectivity. Increased duration of flow would provide greater opportunity for fish that access seasonal habitats to return to more suitable permanent habitat to overwinter and the potential for stranding is expected to be lower than the baseline condition; however, there would continue to be a potential for fish to become stranded in seasonally dewatered habitats.

The SAWSP is expected to result in a net increase in habitat suitability and accessibility for resident forage fish species.

Change in Fish Community Species Composition

The proposed diversion of water from the Red Deer River during operation of the SAWSP is not expected to result in a change in fish community species composition within Lehman Reservoir or downstream portions of the Study Area. There is limited potential that fish would be entrained and transported live from Red Deer River as the diverted water would be screened and driven through several mechanical pumps along the length of the pipeline. Northern pike and white sucker occur in Carolside Reservoir and likely access the lower portions of Berry Creek at least seasonally. The frequency with which fish from Carolside Reservoir can distribute into lower Berry Creek may be increased as a result of temporary barriers in the creek channel being removed and the potential for stranding is expected to decrease as a result of increased duration of flow in the creek. However, the dam at BC-8 Richdale would continue to act as a permanent barrier to fish passage and no change in the potential distribution of northern pike and white sucker is expected to occur. There would likely be an increase in the extent of distribution of existing forage fish species in areas where either existing non-fish bearing habitat becomes accessible (e.g., Oyen Tributary Reservoir) or habitat suitability increases to allow for fish presence (e.g., Craig Lake).

Under Baseline Conditions, the potential for a sustainable population of invasive fish species within the SAWSP is high. The seasonally connected reservoirs and ephemeral creek channels provide habitat that would be highly suitable for hardy, tolerant invasive species. Introduced Prussian carp (*Carassius gibelio*) are known to occur in the Red Deer River near the proposed intake structure (FWMIS 2018). They have also been documented in Carolside Reservoir, and the Bullpound Creek watershed west of Berry Creek (FWMIS 2018). Fish exclusion screening at the intake structure would limit the potential for direct introduction of invasive species to the SAWSP. Designed and existing barriers associated with the SAWSP, including the existing physical barrier to upstream fish passage at BC-8 Richdale, would mitigate the potential for invasive species to gain access to the SAWSP Study Area from downstream. However, the SAWSP may lead to increased human access and recreational use, which could lead to the inadvertant introduction of invasive species at locations of relatively higher recreational use.

The fish community could potentially be altered through introduction of new species to create a recreational sport fishery in either Lehman Reservoir or Oyen Tributary Reservoir. The current SAWSP design does not specifically include introduction of sport fish; therefore, this has not been identified as a residual effect. However, this scenario is introduced and discussed to facilitate assessment during later phases of design. The recreational and social implications of this concept are discussed in Volume III: Socio-economic Assessment, and the biological implications are discussed below. The key issues associated with establishing a recreational fishery include species selection, habitat suitability, potential limiting factors, potential effects on the existing and anticipated aquatic resources, and long-term management requirements.

The species selected to establish a sport fishery in Lehman Reservoir or Oyen Tributary Reservoir could include either species native to Alberta that would be intended to establish a self-sufficient, reproducing population or a non-reproducing population of introduced fish maintained through stocking. Northern pike and walleye are native species that occur in many reservoirs throughout Alberta and that would likely be considered desirable sport fishing targets for resident and visiting anglers. These species are considered cool water species that could potentially occur in the region, provided appropriate habitat was present. Rainbow trout is the species that is most prevalently stocked by AEP in lakes and reservoirs throughout the province and the species is a popular recreational target. Rainbow trout are native to Alberta, but only within the Athabasca River system, and the varieties that are stocked are of an introduced strain. Rainbow trout is considered a cold-water species, but the stocked varieties of rainbow trout are relatively tolerant of elevated water temperatures, as compared to other salmonids.

Northern pike spawn in early spring (April to May), often migrating upstream into tributary creeks to spawn, and the fertilized eggs are deposited on submerged aquatic or flooded terrestrial vegetation (Inskip 1982). Spawning habitat availability is likely the primary factor that would limit the suitability of Lehman or Oyen Tributary Reservoir for northern pike. Lowering the reservoir surface elevation in April would likely coincide with the start of the northern pike spawning period and eggs deposited during falling water levels could become exposed and desiccated. Likewise, lowering the reservoir could reduce the availability of preferred spawning substrates. The portion of Sounding Creek upstream from Lehman Reservoir receives limited natural runoff from snowmelt and would likely provide poor spawning habitat potential. Likewise, the Oyen Inlet Canal would be lined with gravel and likely support limited aquatic vegetation growth and low spawning habitat suitability for pike. Rearing habitat for pike is typically associated with aquatic vegetation and the species is an ambush predator, again using aquatic vegetation as cover to attack prey (Inskip 1982). Northern pike are tolerant of elevated summer water temperatures and are also able to withstand relatively low dissolved oxygen concentrations. Resident forage fish would provide the primary food source for juvenile and adult northern pike. Northern pike could potentially be established in Lehman Reservoir or Oyen Tributary Reservoir and have successfully established in Carolside Reservoir, but fluctuating water levels in spring would likely hinder or prevent spawning and supplemental stocking may be required to enable the species to persist.

Successful introduction of walleye could also likely be hindered by a lack of suitable spawning habitat. The species spawns in the spring, generally commencing shortly after northern pike, and the eggs are deposited over concentrated coarse substrates exposed to wave action or flowing water (McMahon *et al.*1984). The only area of concentrated coarse substrates expected to occur in either reservoir is at the dam face. Additional spawning substrates could be installed as mitigation, though falling water levels in the reservoirs during spawning could expose deposited eggs. Sounding Creek upstream from the reservoir would not provide suitable spawning substrates or sufficient discharge to oxygenate the deposited eggs. There is some potential that suitable spawning habitat could be created in the Oyen Inlet Canal, but there would be a high degree of uncertainty that the habitat would perform as intended by the design. Overall, spawning habitat suitability is expected to be low. The species is also less tolerant of reduced dissolved oxygen concentrations than northern pike and would be at risk of winter kill. Walleye were historically stocked in Carolside Reservoir, but a viable population was not successfully established (Pers. comm., J. Cooper, Fisheries Management, AEP, 2014).

Rainbow trout would not be expected to spawn in the reservoirs or creek channels and the population would not be self-sufficient. Establishing a rainbow trout fishery in Lehman Reservoir or Oyen Tributary Reservoir would require additional management effort and routine stocking would be required to maintain population levels; however, this is a common practice in Alberta and many similar rainbow trout fisheries have been established. Low dissolved oxygen concentrations may pose a risk to this species, similar to walleye, which could result in loss of fish and increase the requirement for stocking.

Of the species discussed, northern pike and walleye would be more dependent upon populations of forage fish, relying primarily on these species as a food source as adults. Rainbow trout diet is typically more diverse and would include a greater concentration of benthic invertebrates such as amphipods. All three species would have a controlling influence on the populations of their food source and would alter the existing food web.

An additional management requirement that should be considered is the need to control movement of the established sport fish species. Downstream movement from either reservoir would effectively result in out-migration from the established population as these fish would not be able to return past the dam. The downstream creek channels would provide only seasonally suitable habitat, but successful overwintering could occur if these fish were to reach a downstream MUP. It is unlikely that walleye or rainbow trout would successfully reproduce and establish new populations within downstream portions of the system, based on the habitat deficiencies discussed previously. However, it is possible that northern pike could persist and establish reproducing populations. Accessibility, seasonal stranding potential, and overwintering potential in the MUPs are expected to improve based on operation of the proposed SAWSP but would continue to pose potential constraints on persistence of northern pike within the system. In any case, the effect of out-migration on the potential for establishing a fish population in Lehman Reservoir or Oyen Tributary Reservoir should be evaluated and fish exclusion measures could be considered if deemed necessary.

Ultimately, establishing a sport fishery within the SAWSP system would require support from AEP Fish and Wildlife Division who would be responsible for managing the fishery.

Sedimentation

Sediment suspended in the water column can affect aquatic organisms directly and indirectly. Deposition of sediment over aquatic macrophytes, algae, and periphyton can affect growth, photosynthetic activity, and community composition (Brookes 1986; Barko and Smart 1986; Wood and Armitage 1997; Robertson *et al.* 2006; Izagirre *et al.* 2009). Suspended sediment can affect primary productivity by reducing light penetration. It can also affect benthic invertebrate and zooplankton community abundance and species composition by altering substrate composition, impeding respiration and filter feeding, and reducing periphyton food value and zooplankton prey density (Rosenberg and Snow 1975; McCabe and O'Brien 1983; Zettler and Carter 1986; Shaw and Richardson 2001; Robertson *et al.* 2006). Effects of increased suspended sediment on fish can include physiological impacts (such as reducing disease tolerance, growth, egg survival, and oxygen exchange via gills), reduced habitat quality and suitability, and reduced food availability (Cordone and Kelly 1961; Bruton 1985; Newcombe and MacDonald 1991; Robertson *et al.* 2006).

Erosion and sedimentation can have effects in both the short- and long-term. Construction activities associated with instream structures such as dam embankments, outlet structures, and spillway channels have the potential to result in release of sediment into aquatic habitats through direct disturbance or surface runoff over disturbed work areas.

As discussed in Section 1.2.4.2, increasing the FSL of reservoirs and MUPs would proportionately increase the perimeter of the shoreline susceptible to wind, wave, and surface runoff erosion. Given that the increase in erosion potential would be roughly proportionate to the increase in aquatic habitat area, there may be elevated concentrations of suspended sediment in localized areas of active erosion, but the average condition within reservoirs and MUPs would not be expected to change during long-term operation. There would likely be a spike in sediment mobilization during initial operation as inundated terrestrial vegetation breaks down and the newly submerged substrates are exposed to wave action. The resulting effects on fish and aquatic invertebrates are expected to include a short-term reduction in habitat suitability and potential physiological effects near active erosion.

The introduction of diversion discharges in addition to natural flows would change the discharge regime in the existing creek channels, with higher, longer duration discharges than those experienced in recent history. The change in discharge regime may induce a channel adaptation response consisting of changes to the channel width, depth and slope. Such changes could result in bank erosion, meander progression, and development of cutoffs, all of which would increase sediment availability and produce increases in sediment transport, deposition, and sediment concentrations. The potential for channel erosion was assessed as a component of the ECS (Volume I: Appendix I) and channel segments were classified according to erosion potential. The management strategy proposed to mitigate the effects of channel erosion included enlargement of existing channels that were undersized and susceptible to erosion. Mobilization of unconsolidated or erodible sediments would likely occur predominantly during the initial period of commissioning and operation and it is expected that this effect would taper off shortly after commissioning. Over the long-term, erosion of the enhanced portions of the creek channels could occur during periods of higher than normal discharge (e.g., heavy rainfall events) or at locations of long-term instability. Sediment transport within a distinct section of creek would likely result in deposition in the nearest downstream reservoir or MUP.

Introduction of Deleterious Substances

Introduction of deleterious substances could occur in several ways during construction within the vicinity of water bodies and could potentially result in negative effects on aquatic habitat in the SAWSP. Hydrocarbon based fuels, hydraulic fluids, and lubricants would be used in construction machinery working within the floodplain and spills or leaks may occur. These substances could potentially enter water bodies directly or be deposited in the riparian area and be transported into the water body by surface runoff.

Hydrocarbons can have a direct effect on:

- development and growth of eggs and juvenile fish (Carls *et al*. 1999; Heintz *et al*. 2000);
- oxygen transport via gill filaments (Hart 1974); and
- fish health by causing histo-pathological damage in the gills, liver, and kidney (Al-Kindi *et al*. 2000).

Polycyclic aromatic hydrocarbons may affect fish by inducing immunotoxicity through an assortment of intra-cellular mechanisms (Reynaud and Deschaux 2006). In addition, hydrocarbons may indirectly affect fish by reducing dissolved oxygen levels within the water column, covering spawning substrate, and impacting invertebrate and macrophyte populations (Hart 1974; Werner *et al*. 1985).

Installation of cast in place concrete structures could potentially affect water quality in adjacent water bodies if exposed to water before the curing process is completed. Leachate from lime material is highly toxic to fish and other aquatic biota and can cause pH to increase sharply (D. McLeay and Associates 1983; Adamu *et al*. 2008; AT 2009). Rapid or extreme water quality changes may result in physiological trauma (e.g., organ damage) or death.

Vehicles and construction equipment, particularly tracked machinery, may also transport biological contaminants to construction sites. These could include noxious or invasive terrestrial or aquatic vegetation such as Didymo algae or diseases such as whirling disease.

Direct Fish Mortality and Stranding

Currently, brook stickleback and fathead minnow are widely distributed throughout the Study Area reservoirs, lakes, MUPs, Berry Creek, Sounding Creek, and Craig Lake Tributary, occupying permanent habitats as well as dispersing into seasonal habitats. Stranding of fish in unsuitable temporary habitats is expected to occur frequently and constitutes a balancing factor that influences forage fish populations. However, the resident species are subject to limited top-down control as no piscivorous fish species occur within the majority of the Study Area. Forage fish are expected to persist in all areas of the Study Area unless the habitat is not accessible (e.g., Oyen Tributary Reservoir) or has unsuitable water quality (e.g., Craig Lake) despite the risks of stranding during dispersal and poor overwintering habitat potential in many of the existing impounded water bodies.

Unless additional species are intentionally introduced, it is expected that brook stickleback and fathead minnow would continue to be the only fish species residing in the majority of the Study Area. There is no potential for fish to be transported from the Red Deer River, and fish migration from the lower reaches of Berry Creek would continue to be impeded by an abundance of barriers.

It is expected that the fish populations that occur permanently in reservoirs, lakes, and MUPs throughout the Study Area would be subjected to a similar risk of stranding as compared to the Baseline Conditions. Fish that travel upstream from the permanent habitat into temporarily accessible creek habitat, or that become entrained at an outlet and are deposited in a downstream creek channel, would have an opportunity to travel downstream during the period of active discharge to potentially suitable overwintering habitat. Fish that remain the seasonally inundated creek channel would face potentially unsuitable winter conditions. The relative risk of stranding is expected to decrease because; the upstream portions of Sounding Creek and Craig Lake Tributary that currently retain little water would be widened to create a defined channel, the duration of discharge is expected to increase, and many of the seasonal barriers to fish passage that occur within the creeks would be removed. As a result, the SAWSP is not expected to increase the risk that fish would access unsuitable habitats, thus screening or exclusion measures have not been proposed. Likewise, active fish rescue within seasonally dewatered creek channels is not proposed.

Construction of temporary isolation structures and isolation or abandonment of segments of creek channel may potentially result in stranding of fish within the isolated work footprint. Stranded fish could be exposed to unsuitable habitat conditions such as elevated suspended sediment concentrations, impaired water quality, or reduced water levels. De-watering of isolated work areas could also result in fish becoming entrained or impinged at the pump intake resulting in stress, damage, or mortality.

Mitigation Strategies and Best Practice Guidelines

Change in Habitat Quantity

Temporary disturbances such as access routes and construction laydown areas would be positioned to avoid additional impacts on aquatic habitat as much as possible. From a construction staging perspective, avoiding wetted areas would reduce logistical concerns and would be preferred over having to apply additional mitigations such as isolation. The potential for permanent reduction in habitat quantity was also considered in designing SAWSP infrastructure, but ultimately incidental losses would be balanced by a significant gain both permanent and temporary habitat and a large net increase in habitat quantity is predicted (Appendix I: Table I-5).

Change in Habitat Suitability and Accessibility

Fish habitat features such as substrate and cover are generally expected to remain similar to existing conditions or to evolve naturally in response to the new hydraulic regime and these changes have been assessed on a SAWSP component specific basis. In general, habitat suitability would not be deliberately managed or enhanced, though incidental benefits would be likely to occur (e.g., increased water permanence leading to increased wetland vegetation occurrence).

Habitat accessibility is expected to be enhanced as a result of the removal of existing seasonal barriers to fish habitat movement that exist within the creek channels. Existing structures such as check dams, ford crossings, and undersized culverts that exist within the creek channels would need to be either removed or upgraded to safely accommodate operational discharge which would result in improved fish passage potential. Another incidental benefit for fish habitat accessibility would be realized as a direct result of increased quantity and duration of discharge within the SAWSP, allowing for increased fish dispersion and reduced stranding potential.

Sedimentation

All AT construction projects are subject to standard mitigation measures for protection of the environment and these requirements are specified in the corresponding contract documents. In addition, AT regularly produces and updates guideline documents that provide direction to contractors on environmental requirements. AT's standard measures that would be incorporated into each of the contracts for the proposed SAWSP include the measures listed in AT's EPP template (Appendix II). It is expected that general effects of construction activities related to introduction or mobilization of sediment in SAWSP water bodies would be mitigated through implementation of standard methods employed on all AT construction projects near water bodies (Appendices II-VI).

The potential for operational increases in sediment mobilization and transport within creek channels would be mitigated as identified in the ECS (Volume I: Appendix I). This would include enlargement of Class 3 (Significant) channel segments to increase channel capacity to contain the design discharge, minimizing the process of channel adjustment predicted to occur if the channel were left to evolve naturally. Modified channel segments would be seeded to re-establish vegetation cover and willow staking or similar bioengineering solutions would be installed to increase roughness of banks. This would effectively reduce water velocity, extend bank stability, and enhance riparian habitat to increase local biodiversity. In addition, reaches of wide and shallow channel would be incorporated into the design to reduce flow velocity and to encourage emergent and semi-aquatic vegetation growth.

Introduction of Deleterious Substances

AT requires a minimum standard of care for all construction contracts which includes standard mitigation measures to prevent spill or release of deleterious substances. It is expected that general effects of construction activities related to introduction of deleterious substances would be mitigated through implementation of standard methods employed on all AT construction projects near water bodies (Appendices II-VI). Cast in place concrete would be allowed to cure for at least 48 hours before being exposed to water. Equipment would arrive at the site clean (no external mud, grease, oils) and free of leaks and mud and dirt should be removed from vehicles and equipment, including tracks and tires, to prevent the transfer of biota of concern (e.g., terrestrial and aquatic weeds and aquatic diseases).

Direct Fish Mortality and Stranding

Fish rescue would be conducted in areas of isolated aquatic habitat to relocate stranded fish to a suitable area. This would include active capture of fish following isolation, typically in conjunction with dewatering. The dewatered habitat area would be inspected to confirm fish rescue effectiveness. Captured fish would be temporarily contained in aerated holding containers, enumerated, and released to an area that would not be affected by ongoing construction activities.

To reduce the potential for fish to be entrained or impinged at pump intakes, an end-of-pipe screen would be installed in accordance with applicable Fisheries and Oceans Canada (DFO) guidelines (1995). The dimensions and materials of the intake screen would be designed to achieve the specified approach velocity criteria during dewatering.

Monitoring Requirements

An important component of the overall environmental monitoring activities and requirements would be the monitoring of TSS levels during construction activities within the wetted perimeter of water bodies within the Study Area. AT has established specifications outlining the sampling methods, frequency, and compliance criteria for TSS monitoring, which is included in the contract for a project that may result in impacts to a water body. It would be the responsibility of the Contractor to ensure that *in situ* TSS monitoring is carried out in accordance with these specifications throughout construction, as required. The Contractor would be responsible for ensuring that the results of the TSS monitoring are reported to the construction manager (Consultant) and that potential concerns are addressed through modification of construction practices or environmental protection measures. Construction monitoring would be required to ensure that erosion and sedimentation are controlled within the construction footprint and that potential impacts to the aquatic environment are controlled.

Operational monitoring would be conducted to confirm the effects predictions regarding erosion and to ascertain where adaptive management may be required to mitigate documented effects. Specifically, annual inspections would be conducted for the first three years of operation to detect areas of active erosion within the creek channels, canals, reservoirs, lakes, and MUPs within the SAWSP system. Additional mitigation would be applied to stabilize areas of concern including installation of willow stakes or other bioengineered stabilization techniques that provide a natural long-term solution. It is expected that, after three years of monitoring, a downwards trend in erosion activity would have been noted, otherwise the monitoring program would need to be extended.

1.3.7 Soils and Terrain

1.3.7.1 Potential Project Effects

Activities that may affect the soil and terrain resources as a result of the SAWSP include:

- Soil salvage and handling: pre-construction soil salvage and handling of soils may result in effects to soil quality.

- Soil stockpiling: stockpiling of salvaged materials during construction activities may result in soil erosion and effects to soil quality and quantity until reclamation is complete.
- Development of SAWSP infrastructure: development of infrastructure and roads that require site contouring may result in effects to soil quality and alteration of terrain.
- Operation of reservoirs and MUPs: flooding and drawdown of reservoirs and MUPs may result in the loss of soils and may affect soil quality due to wave erosion and wind erosion (exposed soil during reservoir drawdown).
- Reclamation: activities including recontouring, soil handling and replacement may result in effects to soil quality and terrain.

A description of the soil and terrain VECs identified in Section 1.2.4.5 is provided in the following sections, along with a discussion of potential environmental effects and proposed implementation of mitigative measures.

Soil Quality and Quantity

Disturbance related to SAWSP construction and reclamation activities may alter soil quality through admixing and compaction (soil profile disturbance), and contamination which may affect structure, texture, and nutrient status. Erosion could lead to soil loss. Changes in agricultural capability and availability of suitable reclamation materials may result from changes in soil quality quantity. Changes in agricultural capability may lead to decreased productivity where soils are unable to support vegetation communities that they supported prior to SAWSP construction. However, in the case of the SAWSP, many areas are expected to increase in productivity due to the SAWSP's support of irrigation for lands near the SAWSP. The assessment on soil quality and quantity would qualitatively consider potential SAWSP effects of admixing, compaction, contamination and erosion considered the potential changes in capability classification ratings due to those changes.

An assessment of reclamation suitability in the Baseline Conditions is provided in the Soil TBR and is used to acertain the extent and quality of available reclamation materials. This would be used to develop appropriate handling strategies for salvage and stockpiling during construction.

Soil Profile Disturbance

Disturbance of the soil profile during construction and reclamation has the potential to impact soil quality. If proper construction techniques are not utilized, there is potential for admixing and/or compaction of soils.

Admixing of topsoil and subsoil components during soil salvage operations may cause soil integrity to be compromised, especially if a clear distinction between the topsoil and upper subsoil cannot be maintained. Effects of admixing on soil quality include change in texture, structure, and nutrient status, and reduction in organic matter content in topsoil horizons.

Compaction is a change in soil structure that occurs when mineral soil particles are pressed together and the pore space between the particles is reduced. Compacted soils have reduced drainage, water infiltration, soil aeration, and root penetration, all of which reduce potential re-vegetation success. Soils that have low organic matter content, are moist or wet, or have fine (clay or silt) textures are highly susceptible to compaction. Construction activities such as stripping and grading, as well as continuous traffic, can lead to compaction and loss of soil structure. Fine textured, compacted soils are also more susceptible to erosion.

Accidental Releases

Potential contaminants to soils during construction include gasoline, diesel fuel, hydraulic fluids, lubricants, coolant, and other deleterious substances. Contaminants may be released into the environment as a result of equipment being in poor repair, mechanical failure, damage sustained during operation, poor fueling practices, or inadequate means of containment during storage. Soil contamination may result in:

- change in nutrient status;
- reduction in soil capability;
- loss of soil structure; and
- change in pH.

With the appropriate environmental management plans in place, accidental releases and subsequent clean-up is expected to result in a low effect on soil quality.

Erosion

The potential effects of wind and water erosion on soil quality and quantity are of concern throughout the construction, operation and reclamation phases of the SAWSP. Erosion may occur at stockpiled soils during construction, during soil replacement at reclamation, and during the operation of canals, channels, reservoirs and MUPs.

Erosion of stockpiled soil may occur by wind and water and result in the loss of extant soils. Soil materials replaced during reclamation are also at risk of erosion by wind and/or water during soil handling activities and immediately after replacement. Soils characterized by coarse texture and low or absent organic matter content are most susceptible to wind erosion. Susceptibility to water erosion is closely tied to slope degree. The risk of erosion remains relatively high until a vegetative cover is re-established, particularly as slopes increase. Over much of the SAWSP Footprint, site recontouring would provide similar landscapes and drainage patterns to pre-disturbance conditions.

Where canals, reservoirs and MUPS would be created or increased in capacity, the areas of exposed shoreline at the soil/water interface would be subjected to various erosive forces, including wind and wave erosion. Submersion and exposure of the land between high and low water levels would inhibit establishment of upland vegetation cover that would lessen or negate wind erosion. This effect is expected to occur in the period between the commencement of drawdown and the start of winter when the ground freezes and is covered with snow. As the reservoir level recedes and the exposed substrate dries out, these areas would be susceptible to wind erosion.

Surface water erosion is likely to occur at reservoirs and MUPS in near shore areas during periods of high rainfall, and at upstream reaches of creek channels where significantly increased discharges are expected.

Soil Diversity

Disturbance related to construction and reclamation activities would result in alteration of the soil types within the LSA. Soil diversity, or the number of soil types present within an area, has the potential to affect biodiversity. Different soil types support different vegetation communities, which in turn support different wildlife communities. Vegetation communities are formed as a result of the relationship between soil and landscape patterns and corresponding moisture and nutrient regimes. Reclamation of soil and landscape patterns to provide similar agricultural capability would allow for the eventual formation vegetation communities that meet desired end land use objectives; however, there would be a permanent loss of soil map unit types where SAWSP infrastructure would be located, and where reservoirs and MUPs would be developed or increased in capacity. The assessment of effects to soil diversity would be focused on loss or alteration of soil map unit types.

Alteration of Terrain

Disturbance related to construction and reclamation activities would result in alteration of terrain types and topography within the LSAs. Terrain diversity can be defined as the number of terrain types present within an area. Diverse terrain types have a tendency to support a diversity of soil types as well as diverse vegetation communities.

During SAWSP construction, a number of terrain types in the SAWSP Footprint would be disturbed. While topography would be leveled as necessary for construction, during the reclamation phase many areas would be re-contoured to blend in with surrounding areas. However, after reclamation, there would be some permanent losses of upland terrain to waterbodies/shallow wetlands due to creation of canals and development or increase in capacity of reservoirs and MUPs.

1.3.7.2 Mitigation Strategies and Best Practice Guidelines

Soil Quality and Quantity

Soil Profile Disturbance

The AT EPP (Appendix II) would be used to prevent or mitigate potential effects that could occur during construction. A site-specific ECO Plan would be prepared by the Contractor in accordance with the AT ECO Plan Framework (Appendix III). These policies would be the primary controls during construction.

General mitigation and best practices would be implemented at each construction site (Appendix I: Table I-6). In summary, the following standard practices would be used to remove or reduce adverse effects to soils:

- Minimize construction, laydown and access footprints to minimize the need to strip topsoil.
- In areas of native grassland, topsoil would be salvaged, stockpiled and replaced separately from other areas, to protect the seedbed and enhance revegetation.
- Topsoil would be stripped to the depths indicated on the stripping plan or as otherwise directed by the Consultant. Topsoil salvage would only be undertaken during daylight hours to ensure depth of topsoil can be identified.
- Topsoil would be stripped and replaced under non-frozen and non-saturated soil conditions. If topsoil must be stripped under frozen and/or saturated soil conditions due to timing constraints or site conditions, a topsoil handling plan specific to the locations and conditions encountered would be prepared prior to commencing topsoil stripping activities.
- When handling wet or saturated topsoil extra care would be taken to minimize damage to the soil structure.
- Topsoil would be conserved. Topsoil would not be used for road bed material.
- Topsoil would be stockpiled separately from subsoil stockpiles.
- For areas to be revegetated, visual evidence (e.g., rutting) and compaction testing (e.g., shovel penetration) would be used to determine if there are compaction problem areas. Compaction would be relieved to a depth identified by the Consultant.
- Equipment travel and operation would be suspended or modified where rutting problems on wet ground are jeopardizing topsoil structure and integrity.

Erosion

Monitoring of ESC measures during construction would be a requirement of the ECO Plan to be created by the Contractor.

The following are general practices to be implemented to prevent or minimize impacts of erosion and sediment during construction:

- If topsoil is to be stockpiled for periods exceeding two months the Contractor would protect the stockpile from erosion. Where persistent high winds are eroding soil berms or piles, or removing topsoil from the ROW, contingency measures to stabilize the soil would be implemented.
- Sediment and erosion control measures would be implemented prior to work and maintained during the work phase until the site has been stabilized. The sediment and erosion control measures would be inspected regularly.
- Any deterioration/damage to silt fence or other ESC measures would be repaired as soon as possible and construction would be halted until repairs are completed.

- Sufficient quantities of ESC supplies (such as silt fence or geotextile fabric) would be maintained on site such to address issues as the work progresses.
- Erodible soils would be stabilized in a timely fashion after grading is completed.
- Surface runoff would be directed to vegetated areas where possible, or settling ponds as required.
- A construction monitoring and inspection program would be implemented to make sure ESC measures are in place and in good working order (Appendix VI). Should a storm event be predicted, all installed ESC measures would be inspected and additional controls implemented as necessary.
- Extra caution would be exercised in areas of steep slopes, erodible soils, wet areas, and watercourses.

To mitigate the anticipated increases in wind and wave erosion during operation of reservoirs and MUPS, shorelines would be re-graded to a more natural gradient, resilient to wind and wave erosion, where possible. Erosion protection would be required on the upstream slopes of the dam embankments to resist erosion due to wind-generated waves. Upstream reaches of creeks would be enlarged to reduce the potential erosion associated with increased discharges. Gravel armour bank protection would be installed at canals to resist erosion and slope instability during canal drawdown. Drainlet structures would also be installed permit surface water runoff that is intercepted by the canal to safely enter the canal without causing erosion and/or compromising the canal bank.

Accidental Releases

A fuel/deleterious substance spill response plan would be in place of the component specific ECO Plan to be created by the Contractor. An emergency spill response kit would be kept on-site during construction. All spills would be cleaned up immediately and reported according to the procedures in the ECO Plan (Appendix III).

Soil Diversity

SAWSP reclamation would aim to create soil landscape patterns similar to pre-disturbance conditions such that equivalent agricultural capability is met where possible. The landscape would be developed to meet desired end land uses. There would be a permanent loss of agricultural capability where upland areas are converted to waterbodies through the creation of canals, reservoirs, and MUPS. However, there are also areas with expected increase in agricultural capability as a result of the SAWSP's provision of irrigation water (Volume III).

Alteration of Terrain

Impacts to terrain would be mitigated through appropriate recontouring of reclaimed landscapes to provide topography and surface forms that provide appropriate surface drainage, blend with adjacent undisturbed terrain, and remain stable. Instances where the reclaimed landscape is expected to differ from the original terrain type (i.e., canals, reservoirs, and MUPs), the landscape would be designed to be compatible with end land use objectives.

Earthfill borrow materials for SAWSP dams would be provided from borrow areas located within the future FSL of proposed reservoirs and MUPs. By utilizing borrow sources below the future FSL, it is intended that the area of disturbance is limited to areas that would eventually be inundated. Since these areas would be inundated within the wetted perimeter of the reservoir, reclamation would not be required and therefore costs would be minimized. Borrow areas would be graded afterwards to promote drainage during periods of drawdown.

1.3.8 Vegetation and Wetlands

Potential Project Effects

Potential effects of the SAWSP on vegetation and wetland habitat may include:

- change to wetlands:
  - removal;
  - reduced ecological function;
  - sedimentation;
  - invasive species encroachment; and
  - creation of new wetlands.
- changes to rare plant habitat quantity and quantity:
  - land conversion; and
  - shifts in animal distribution.
- loss of rare plants or rare plant communities;
- loss of native grasslands:
  - conversion of plant communities during land use conversion;
  - removal of natural vegetation;
  - inundation; and
  - invasive species encroachment.

Change to Wetlands

The potential effects to wetlands during construction would be temporary disturbance to wetlands, or their permanent removal. The potential effects of temporary disturbance could include a reduction in biodiversity, introduction of invasive species, loss of ecological integrity, and potential impacts to water storage and infiltration within the wetlands. The potential effects of removal of a wetland permanently could include loss of biodiversity, loss of watering sources, loss of ground water recharge, reduced habitat for wildlife and rare plants, increased runoff, increased potential for flooding and loss of flood attenuation. An increase in wetlands would have the inverse effects. The predicted net change in wetlands is summarized in Table 1.12.

Where existing wetlands within reservoirs and MUPs are inundated during operations, wetland habitat may become degraded or could be lost to open water (areas with water deeper than 2m). These non-wetland areas would be classified as permanent, open water and not wetland habitat. However, permanent water bodies would provide habitat for some wildlife. Possibilty for recreation may also be created with the expanasion of open water (Section 1.3.3).

Existing wetlands associated with the existing creek channels could become altered or degraded under a new hydrologic regime. Wetlands may also be created within channels that are subjected to increased water flows and permanence.

Table 1.12 Predicted Changes to Wetlands with the Proposed SAWSP Components

Project Component	Impact Description	Baseline Conditions						Design				Net Change
		FSL (ha)	NOL (ha)	Permanently >2m (ha)	Reservoir / MUP Wetland (ha)	Additional Wetland Inundated or Displaced (ha)	Total Affected Wetland (ha)	FSL (ha)	NOL (ha)	Permanently >2m (ha)	Project Case Wetland (ha)	Wetland (ha)
Lehman Reservoir	Lehman Reservoir footprint	134.7	-	19.2	115.5	11.3	126.8	649.2	-	434.2	215.0	88.2
	Diversion canals	-	-	-	-	4.1	4.1	-	-	-	0.0	-4.1
Oyen Tributary System	Diversion Reservoir footprint	-	-	-	-	8.6	8.6	89.8	-	58.1	31.7	23.1
	Oyen Tributary Reservoir footprint	50.3	-	0.0	50.3	10.3	60.6	395.4	-	241.9	153.5	92.9
	Oyen Inlet canal	-	-	-	-	0.8	0.8		-	-	0.0	-0.8
	Sounding Creek Reservoir	159.2	-	0.0	159.2	1.7	160.9	145.0	-	0.0	145.0	-15.9
Craig Lake Bypass Canal	Canal footprint	-	-	-	-	3.0	3.0	0.0	-	-	0.0	-3.0
Scaupshovel Bypass Canal	Canal footprint	-	-	-	-	0.7	0.7	0.0	-	-	0.0	-0.7
	Diversion headpond	-	-	-	-	0.8	0.8	4.0	-	0.0	4.0	3.2
Antelope Lake Bypass Canal	Canal footprint	-	-	-	-	1.0	1.0	0.0	-	-	0.0	-1.0
	Diversion headpond	-	-	-	-	9.2	9.2	45.1	-	0.0	45.1	35.9
Esther Hay Meadow Bypass Canal	Canal footprint	-	-	-	-	13.9	13.9	0.0	-	-	0.0	-13.9
	Diversion headpond	-	-	-	-	0.2	0.2	2.0	-	0.0	2.0	1.8
BC-4 Fertility	MUP and infrastructure footprint	-	-	-	-	15.7	15.7	104.6	61.5	0.0	104.6	88.9
BC-5 Dale	MUP and infrastructure footprint	21.8	13.9	0.0	21.8	9.0	30.8	40.4	13.9	0.0	40.4	9.6
BC-7 Contracosta	MUP and infrastructure footprint	538.7	77.7	0.0	538.7	16.3	555.0	631.7	77.7	0.0	631.7	76.7
BC-8 Richdale	MUP and infrastructure footprint	26.5	26.5	1.0	25.5	1.4	26.9	45.2	45.2	1.0	44.2	17.3
SO-5-6 Motz	MUP and infrastructure footprint	59.1	21.7	1.6	57.5	1.1	58.6	73.6	31.8	2.5	71.1	12.5
SO-7 Mitchell	MUP and infrastructure footprint	40.5	12.0	1.1	39.4	1.4	40.8	43.8	16.4	1.7	42.1	1.3
SO-10 Wingding	MUP and infrastructure footprint	43.7	21.0	0.0	43.7	2.9	46.6	47.1	24.3	0.0	47.1	0.5
SO-11 Scaupshovel	MUP and infrastructure footprint	61.6	6.1	0.0	61.6	3.4	65.0	106.0	19.3	0.0	106.0	41.0
SO-39 Esther Hay Meadow	MUP and infrastructure footprint	585.6	6.7	0.0	585.6	8.1	593.7	862.7	60.5	0.0	862.7	269.0
CR-6 Craig Lake	MUP and infrastructure footprint	515.5	320.7	0.0	515.5	1.2	516.7	625.3	320.7	0.0	625.3	108.6
CR-8 Sneath	MUP and infrastructure footprint	47.5	13.7	0.0	47.5	0.7	48.2	48.6	13.7	0.0	48.6	0.4
CR-10 Peter	MUP and infrastructure footprint	30.5	6.1	0.0	30.5	0.3	30.8	32.5	6.1	0.0	32.5	1.7
CR-13 Loon Slough	MUP and infrastructure footprint	81.4	40.4	0.0	81.4	0.4	81.8	118.6	40.4	0.0	118.6	36.8
CR-14 Scoville	MUP and infrastructure footprint	27.4	19.0	0.0	27.4	3.8	31.2	73.9	34.3	0.0	73.9	42.7
	Totals	**2424.0**	**585.5**	**22.9**	**2401.1**	**131.3**	**2532.4**	**4184.5**	**765.8**	**739.4**	**3445.1**	**912.7**

Change in Rare Plant and Rare Plant Community Habitat Quality and Quantity

The SAWSP would have the potential to modify habitat for rare plants and plant communities along the SAWSP route in multiple ways. Habitat loss would equate to a reduction of areas that currently have, may have historically included, or could potentially provide suitable conditions for rare plants. The degree of change would be dependent on the final design and construction plan of the SAWSP.

The forms of habitat modification could include modification of topography (dams, canals, channels, blowout leveling, changes to slopes, etc.), changes in land use (grazing, aquatic/wetland habitat vs. upland habitat, type of agriculture, infrastructure creation, etc.), modification of soils (tillage vs. untilled, erosion, admixing, etc.), change to the hydrologic regime (wet and dry cycle, salinity, nutrient, etc.), and shifts within the disturbance regimes along the SAWSP footprint (grazing access and animal distribution, cultivation versus permanent pasture, etc.). Some of these impacts would be directly related to construction (reservoirs, canals, MUPs), while others would be related to operations of the SAWSP (water regime, animal distribution both wildlife and domestic). Each of these changes may result in changes in the habitat quality for rare plants and rare plant communities along the SAWSP footprint. In some cases, there would be improved habitat and in other cases the quality of habitat would be reduced or eliminated. In general, within and immediately adjacent the water conveyance system, species that thrive on abundant soil moisture would see increased habitat potential, while upland and dry land species would see reduced habitat potential.

Overall, the SAWSP would lead to the loss of habitat for some terrestrial species, and possibly wetland species. There would be a few species that would benefit such as *Gratiola neglecta, Atriplex powellii, Muhlenbergia asperifolia*, and *Atriplex canescens*. These species either thrive with some limited level of soil disturbance (*Gratiola neglecta, Atriplex powellii,* and *Atriplex canescens*) or near reliable water sources such as wetland edges and creek edges (*Muhlenbergia asperifolia*). However, the habitat of most other species would be adversely changed with a new hydrologic regime or complete inundation.

Loss of Rare Plants and Rare Plant Communities

Construction may lead to the direct removal of rare plants and rare plant communities. Many of the rare species documented (e.gs. *Muhlenbergii asperifolia, Gratiola neglecta, Heliotropium curassavicum, Lysimachia hybrida, Marsilea vestita, Almutaster pauciflorus, Corispermum hyssopifolium, Spergularia salina,* and *Sphenopholis obtusata*) are found on the edge of the watercourses, reservoirs, or within the MUPs (Volume IV: Vegetation and Wetlands TBR). These species thrive on the transition between upland and wetland conditions and as such could be within the construction footprint. A number of the rare plant communities are also found in the same conditions including: *Distichlis spicata – Pascopyrum smithii* community, *Pascopyrum smithii-Carex stenophylla* community, *Pascopyrum smithii-Hordeum jubatum* community, *Puccinellia nuttalliana* community, the *Salicornia rubra* emergent marsh, *Muhlenbergia asperifolia-Scirpus nevadensis – Distichlis spicata* community, and the *Sarcobatus vermiculatus-Pascopyrum smithii* community. The complete removal of some local populations of rare plants may occur within the footprint of the SAWSP. Others could see portions of populations displaced.

Loss of Native Grasslands

The SAWSP would lead to permanent changes in plant communities across the footprint of the SAWSP. Changes to reservoirs, channels, canals, and MUPs would lead to changes in plant communities and biodiversity; including the shift between upland grassland communities that would be replaced by wetland communities and open water. The shift would include the inundation of some climax fescue grasslands and needle grass communities.

Mitigation Strategies and Best Practice Guidelines

Change to Wetlands

Wetland mitigation is regulated under the Alberta Wetland Policy, (Government of Alberta 2013c) the *Water Act* (R.S.A 2000, c. W-3), and the *Public Lands Act* (R.S.A 2000, c. P-40). Disturbance to a wetland would need to conform to current provincial regulations. Prior to construction activity, potentially affected wetlands would be assessed and classified (Government of Alberta, 2015c, 2015d, 2015e, and 2015f) by a qualified professional wetland-science practitioner (Appendix I: Table I-7). Potential changes to wetlands would be documented in wetland classification and compensation reporting to be reviewed by AEP. Options to avoid wetlands would include circumnavigating or directionally drilling under them (Volume I: Appendix I). Permanently displaced wetland habitat would require replacement or compensation (Government of Alberta, 2015c, 2015d, 2015e, and 2015f).

Alberta Transportation's EPP includes measures that directly address clearing vegetation, weed and invasive species management, and wetlands and watercourses (Appendix II). The EPP recognizes federal and provincial regulations that protect habitat for species at risk and rare species. The *General Requirements* under AT's *Civil Works Master Specifications* also outline best practices for contractors (Appendix IV). The standard practices detailed in the AT EPP (Appendix II) would be implemented to prevent or minimize the effects to wetlands, watercourses and riparian areas (Appendix I; Table I-7).

Mitigations listed in Appendix I; Table I-7 include, but are not limited to:

- In stream construction would be undertaken according to the conditions provided in Authorizations/Approvals/Operations Statements issued by DFO and AENV.
- The Contractor would minimize disturbance to aquatic resources during construction.
- ESC measures would be implemented prior to work to prevent sediment from entering the wetland. The ESC measures would be inspected regularly.
- When permitted, crossings would be restricted to a single location and would occur perpendicular to and at a narrow point on the wetland.
- Grading would be controlled as much as practical near wetlands and watercourses.
- Where suitable topsoil exists on wetland perimeters, it should be stripped and stockpiled separately.

- To avoid spreading of (aquatic) invasive plant species, equipment utilized around wetlands and watercourses would be thoroughly cleaned.
- Excavation in wetlands would be carried out by an excavator operating from a dry stable surface, when possible, to minimize sediment generation.
- Ditches would not drain directly to wetlands. Flows must be directed away from wetlands by take-off ditches for dissipation through settling ponds and/or adjacent vegetated areas.
- Water crossing construction would be postponed if excessive flows or flood conditions are present or anticipated.
- Pump capacity would be adequate for diverting the necessary flow volumes.
- If cast-in-place concrete is required, all work must be done in the dry and be isolated from water for a minimum of 48 hours.
- Where rock is required, streambeds would be backfilled with washed rock material or other approved clean substrate, preferably river run stone rather than angular.
- Riprap (if used for stabilizing abutments) would not alter channel width and would be free of silt.
- If seeding cannot occur until the following spring appropriate erosion control measures would be implemented to provide short-term ground cover.
- Riparian areas along major watercourse banks would be revegetated in appropriate areas according to detailed design, or as otherwise stated in Authorizations/ Approvals issued by DFO and AENV. Fertilizer would not be used in riparian areas.
- Retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation.
- Stumps would be left intact on approach slopes and stream banks, where feasible, to provide surface stability.
- Clean up of watercourse areas would commence immediately following final contouring and erosion control operations. Clean up would be completed as quickly as practicable (within stream construction timing guidelines).
- Wherever possible, biodegradable oils and lubricants would be used in equipment.
- A fuel/deleterious substance spill response plan would be in place.

Change in Rare Plant and Rare Plant Communities

To reduce the long-term reclamation costs and to maintain ecological integrity, disturbance of native grasslands which may contain rare plants, rare plant communities, and/or suitable habitat for rare plants and communities would be avoided or reduced (Appendix I: Table I-7). Where avoidance of the SAWSP footprint is not possible, areas of unbroken land would require pre-disturbance vegetation surveys for the development of site-specific reclamation plans. The surveys would be conducted by qualified biologists or agrologists to determine the risk to rare plants, rare plant communities, and their habitat. If avoidance is not possible, both seed and live plant material would be collected by qualified greenhouse personnel with experience in the collection and propagation of native plants. This material would be used for the restoration and or re-introduction into suitable habitats. The standard practices detailed in the AT EPP (Appendix II) would be implemented to prevent or minimize the effects to rare plants and rare plant communities (Appendix I; Table I-7).

Native grasslands are extremely difficult to reclaim and many of the plant communities found within the SAWSP Component footprints are either rare or have proven to be difficult to reclaim. The standard practices provided by the AT EPP (Appendix II) and the AT CWMS (Appendix IV) would be implemented to prevent or minimize the effects to native grasslands, rare plants and rare plant communities (Appendix I; Table I-7). To reduce the long-term reclamation costs and to maintain ecological integrity, disturbance of native grasslands would be avoided or minimized. Areas of unbroken land would require pre-construction vegetation surveys for the development of site-specific reclamation plans. The surveys would be performed by a qualified biologist or agrologist.

Minimal disturbance techniques are outlined in the recovery strategies for industrial development in native prairie for the Dry Mixedgrass Natural Subregion (Neville 2013). These techniques include:

- Use Existing Access - Where possible, existing trails across unbroken land would be used for access. Existing trails can include oil and gas access roads, farm trails, road allowances, or abandoned roads/trails.
- Temporary Access in Frozen Conditions - Where no existing trails exist, construction would occur in the winter as the use of frozen roads would prevent the requirement for soil stripping.
- Temporary Access with Rig Matting - Rig matting could be used to reduce compaction and disturbance of native vegetation where access is not available.
- Permanent Trail Access Points - Where permanent roads are constructed within native grasslands, the footprint of the access would be minimized. Tracks would be graveled to remove the requirement of soil stripping and to prolong the trail durability.
- Equipment Cleaning – To prevent the introduction of weeds, all equipment would be cleaned and washed prior to entering native grasslands.

Re-vegetation

For each SAWSP Component, a detailed re-vegetation plan would be completed. This plan would include seed mixes that are site specific and match the plant communities surrounding the disturbance or match the community to be created. Seed mixes would be created on a seeds/m^2 basis and follow the protocols provided by SAB or outlined in the Plant Material Selection and Seed Mix Design for Native Grassland Restoration Projects (Tannas et al. 2016). Where bio-engineering features would be required for bank stabilization, a bio-engineering specialist would design such features.

Vegetation Management

If the land is used for grazing, vegetation management may need to be implemented. Management would include installing fencing around reclaimed areas to prevent grazing and/or damage resulting from hoof shearing or compaction. Fencing would remain place until vegetation has reached a point where grazing would not affect sustainability (generally two to three years).

Weed and Pest Control

Pre-disturbance surveys would be used identify invasive species of concern (Appendix I: Table I-7). Species of concern include all regulated weeds. Post-construction weed surveys would be conducted to determine if weed control is required. Weed control during the first two years is critical for the establishment of native plants. Periodic pest surveys would be conducted to determine if control measures need to be implemented. The timing of the surveys and the pest species of concern can be determined by consulting with an area agrologist and the land owner. Once the surveys have been completed, control measures, if necessary, would be implemented.

Offsets

For rare plant communities and critical climax plant communities, offset reclamation could be completed to offset potential reductions in these rare grasslands. Specifically, grassland where *Festuca hallii* is a dominant species or that contains any listed rare plant community, could be included in some form of conservation easement program to offset what may be reduced due to inundation or the construction of SAWSP components.

Monitoring Requirements

The mitigation policies noted above would be implemented to reduce or remove the predicted adverse environmental effects to vegetation and wetlands. Pre-disturbance surveys would be required prior to construction. Rare plants and rare plant communities located adjacent to ground disturbance (excavations, laydown areas, parking areas, road access) would be flagged and monitored during construction to confirm critical vegetation is not disturbed. If plants are within the disturbance footprint, a vegetation ecologist or agrologst with experience propagating rare species would relocate the plant to a secure location. Areas of relocation would be monitored for construction +5 years for successful reestablishment of native vegetation and for weed encroachment. Where relocation success is not achieved, corrective actions and continued monitoring would be required until the plant communities are successfully reclaimed.

Prohibited noxious and/or noxious weeds found would be controlled as per the *Weed Control Act* (S.A. 2008, c. W-5.1). Other nuisance or volunteer weeds would need to be controlled should they be present in greater densities or occurrences than the adjacent field or they were determined to be of significant ecological threat by municipalities (Special Areas Board or Counties). Required spraying would be done in compliance of land owner requirements. In addition to weeds on the regulated weed list within Alberta, the following species would require control or management during reclamation as they are controlled by the Special Areas Board:

- Crested Wheat Grass;
- Sweet Clover;
- Alfalfa; and
- Smooth Brome.

1.3.9 Wildlife and Wildlife Habitat

Potential Project Effects

Potential SAWSP effects were determined based on the impacts associated with the construction and operation of SAWSP. Clearing of terrestrial habitat and the inundation of both terrestrial and aquatic habitat would be required during the development of the SAWSP components. The clearance and inundation of habitat may also result in mortality to wildlife and or the disruption of behavior and or ecological life requisites. Most of the effects have the potential to occur throughout the SAWSP and can be addressed through AT's general mitigation strategies and best practices (Appendix I: Table I-8).

Based on the impact of the development and operation of the SAWSP, the potential effects of the SAWSP on wildlife include:

- direct changes in habitat suitability and availability;
- indirect changes in habitat suitability and availability;
- disruption to habitat connectivity;
- direct mortality; and
- indirect mortality.

<u>Direct Changes in Habitat Suitability and Availability</u>

The removal and or disturbance of vegetation for the construction of the SAWSP may lead to a direct loss of suitable habitat for wildlife. Habitat loss associated with SAWSP development is commonly equated with the reduction of forest cover. The region in which the SAWSP is proposed is largely devoid of treed and shrub habitat (less than 3% of the land cover; refer Volume IV: Wildlife TBR), thus a minimal reduction in forest is expected. However, grassland habitat is key to the ecology of most prairie wildlife, with many of the bird species nesting on the ground, and many mammal species burrowing for cover. Grassland habitat is also the foundation of the prairie food web, with predators dependent upon prey which forage in or on the grasses of the prairie ecosystem. Therefore, the clearing of most land cover for the construction of the SAWSP is expected to affect habitat availability to wildlife.

A reduction in habitat not only affects direct availability of habitat but can also lead to fragmentation effects. Many species of wildlife are associated with large areas of core habitat (Davis 2004; Winter *et al*. 2006; Ribic *et al*. 2009). For example, Sprague's pipits and bobolinks are species that require large areas of contiguous native grassland habitat for breeding (Davis *et al*. 2014; Renfrew *et al*. 2015). A linear project corridor has the potential to introduce unsuitable habitat across a patch of suitable habitat, bisecting the single patch and creating smaller patches. Remnant habitat patches may become separated by a distance that makes them effectively disconnected to wildlife with small home ranges. Fragmentation of habitat can introduce adverse effects and lead to a reduction in habitat quality. Edge effects such as increased predator pressures, creation of habitat islands, or degradation of pure habitat types along newly created edges can become prevalent.

During the operation of the SAWSP, terrestrial habitat is also expected to be inundated by the waters of the expanding reservoirs or displaced by the footprints of the bypass canals and infrastructure. Also, during operations habitat quality may be affected by the SAWSP by incomplete reclamation of disturbed areas. Where natural habitat is disturbed, the replacement land cover may not have the same suitability to wildlife as what was present before the disturbance.

In addition to grassland habitat, many prairie wildlife species depend on wetlands and watercourses for breeding, protection from predators, and foraging. The SAWSP is expected to increase the quantity and duration of water availability throughout the Sounding Creek and Berry Creek watersheds. While terrestrial habitat may decrease due to the SAWSP, a reciprocal increase in wetland and ephemeral habitat is expected. However, during construction, existing aquatic habitat may be adversely affecting by construction activity. Instream habitat used by amphibians, birds and other semi-aquatic wildlife could be degraded through releases of sediment and deleterious materials.

Indirect Changes in Habitat Suitability and Availability

The suitability and availability of habitat for wildlife can be reduced indirectly through disturbance. An increase in the presence of noise, light, construction activity, and traffic can lead to the deterrence of wildlife from habitat normally used by wildlife under Baseline Conditions. The prevalence of human disturbance and activity in the region in which the SAWSP is proposed is very low under Baseline Conditions. Most of the wildlife in the region would not normally be exposed to constant, noisy activity such as what would be found at a construction site. Such disturbance may temporarily displace some wildlife species from normally useable habitat, thus indirectly reducing habitat availability.

Disruption to Habitat Connectivity

Wildlife move across a landscape to take advantage of available food sources, escape predators, find mates, or to colonize unused habitat patches. The development of linear projects cannot only fragment habitat, but it can introduce barriers to the movements of terrestrial wildlife species (Jones 2009). During operations, SAWSP elements such as canals and fencing have the potential to hinder dispersal and migratory movements of mammals, reptiles, and amphibians. During construction, open trenching, soil stockpiles, and temporary fencing can also disrupt the movements of some species. For example, amphibian movements between breeding habitats and overwintering hibernacula could be hindered if pathways between wetlands and upland hibernacula habitats become obstructed by equipment, trenches, or mounds of soil. Long sections of exclusion fencing, either temporary or permanent) have the potential to prohibit the movement of some species of wildlife. For example, improper fencing may prevent the migratory movements of pronghorn

(Jones 2009). Lined canals can also introduce impedances to movements due steep banks with little traction (Gačić *et al*. 2013; Bucci and Krausman 2015).

Direct Mortality

Direct mortality to wildlife can result when SAWSP construction or operation activities directly lead to the death of animals. During construction, the clearance of habitat can lead to an increased risk of wildlife mortality. The mechanical removal of habitat occupied by breeding, roosting, or foraging wildlife can lead to the loss of wildlife, especially small and less mobile species. Concealed wildlife may also be at risk, as their defense strategy may be to remain hidden as habitat is removed. Habitat that may be affected includes sub-surface burrows. The loss of active nests, burrows, and hibernacula due to the raising of water levels in reservoirs may also contribute to an increased risk of direct mortality.

The increased prevalence of traffic, especially during construction, may lead to an increase in vehicle–wildlife collisions. The occurrence of collisions would be expected to increase in frequency during hours of darkness.

Direct mortality could also result from in-water activity. Physical disturbance of substrates, along with the release of deleterious substances into water could cause mortality of stream-dwelling or wetland species such as amphibians. Direct mortality can also be linked to human activity. Unregulated hunting at construction sites or along access roads can lead to wildlife mortality. Exposure of wildlife to accidental releases of toxic substances can also lead to the unintentional death of wildlife.

With respect to operations, wildlife mortality may occur in lined canals. Steep banks and a lack of traction for hoofed wildlife can lead to slips into canal waters and subsequent drowning (Gačić *et al*. 2013; Bucci and Krausman 2015).

Indirect Mortality

When the immediate effect of the development is not directly linked to wildlife mortality, but the effect leads to circumstances where wildlife perishes, the result is indirect wildlife mortality. Sensory disturbance has the potential to cause nest or den abandonment and reduced mating success immediately adjacent to continuously noisy features or activity (Habib *et al*. 2007, Bayne *et al*. 2008). Ultimately, if breeding wildlife do not return to nests or dens in time, young may perish due to exposure to weather or changes in temperature, availability to predators, or starvation.

In addition to noise and activity disturbances, light may also cause indirect mortality. Nocturnally active wildlife species may be drawn to artificial lighting sources and be exposed to increased predator pressures. Bats, nocturnal rodents and other nocturnal mammals respond to clear moonlight conditions by a decrease in foraging and a decrease in activity and distance traveled when moving through their habitat (Beier 2006). A decrease in overall activity and a shortening of the distance in movements are likely associated with a predation risk response (Bird *et al*., 2004).

A reduction in foraging habitat can also cause a reduction in local food availability and subsequent mortality of wildlife, particularly young, through reduced energy intake. This effect could occur where areas of critical forage habitat is removed from an area where that type of habitat is limited within the home ranges of breeding wildlife.

Physical disturbance of substrates, along with the release of deleterious substances into water could cause indirect mortality of stream-dwelling or wetland species such as amphibians. Changes to water quality may adversely disrupt food-webs (Cordone and Kelly 1961; Newcombe and MacDonald 1991; Wood and Armitage 1997; Henley *et al*. 2000).

Mitigation Strategies and Best Practice Guidelines

AT's EPP includes measures that directly address habitat for species at risk and rare species (Appendix II). The EPP recognizes federal and provincial regulations that protect both wildlife and wildlife habitat. The *General Requirements* under AT's CWMS also outline best practices for contractors (Appendix IV).

Direct and Indirect Changes in Habitat Suitability and Availability

The following standard practices would be implemented to prevent or reduce the effects to wildlife habitat suitability and availability:

- Identified setback distances would be maintained between construction operations and the habitat of designated wildlife species during critical life stages or seasons.
- Right-of-way (ROW) accesses, approved temporary workspaces, and environmentally sensitive sites within the ROW would be clearly identified by staking or flagging prior to the start of construction.
- Seed containing restricted or noxious weeds would not be accepted for use.
- The Contractor would minimize disturbance to aquatic resources during construction and retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation and disturbance of riparian habitat. The buffer would be fenced using silt fence or a similar barrier, to prevent equipment and machinery from encroaching into protected areas.

Indirect Changes in Habitat Suitability and Availability

The following standard practices would be implemented to prevent or minimize the indirect effects to wildlife habitat suitability and availability:

- The Contractor is to implement setbacks where no construction activities would take place around locations where breeding wildlife and species at risk are known to occur.
- The Contractor would retain an undisturbed vegetation buffer between the construction site and watercourse to reduce the potential for sedimentation. The buffer would be fenced using silt fence or a similar barrier, to prevent equipment and machinery from encroaching into protected areas.

Disruption to Habitat Connectivity

The following standard practices would be implemented to prevent or reduce the effects to wildlife habitat connectivity:

- Retain an undisturbed vegetation buffer between the construction site and watercourse to preserve connectivity of riparian habitat and to prevent equipment and machinery from encroaching into sensitive habitat.
- Riparian areas along major watercourse banks would be revegetated in appropriate areas according to detailed design, or as otherwise stated in regulatory approvals.
- Seed containing restricted or noxious weeds would not be accepted for use for revegetation to prevent fragmentation of grassland habitat.
- Use pronghorn friendly fencing around SAWSP components.
- Canals to include regularly available crossing points (landowner and cattle crossings).

Direct Mortality

The following standard practices would be implemented to prevent or reduce the effects of direct mortality to wildlife:

- The EPP directs an ECO Plan to include the identification of appropriate temporal windows for conducting work in areas where breeding migratory birds and species at risk are present (Appendices II and III):
  - No one would disturb, move or destroy migratory bird nests or the residences of species at risk;
  - Pre-disturbance sweeps would be conducted during sensitive breeding periods for wildlife;
  - If an active nest or residence of a species at risk are encountered, the Contractor would cease work in the immediate area of the nest and inform the environmental manager; and
  - The environmental manager would notify AEP and Environment and Climate Change Canada and wait for direction from these authorities prior to resuming work in the area of the nest or residence of a species at risk.
- Environmental contingency plans must be developed to describe potential incidents and the procedures that would be implemented to address any incidents. Environmental contingency plans would include:
  - Emergency Response Procedures;
  - Contaminant Spills and Releases;
  - Erosion Events; and
  - Erosion and sedimentation.

- A fuel/deleterious substance spill response plan would be in place. An emergency spill response kit would be kept on-site during construction.
- Equipment would be refueled and serviced to ensure that deleterious substances do not enter any watercourse. Equipment operating near any watercourse would be clean and free of external oil, grease, mud, or fluid leaks.
- Incidence of problem wildlife near the SAWSP would be reported to local AEP conservation officers who would provide mitigation measures.
- Potential collisions between construction vehicles and wildlife would be mitigated through adherenace to site speed limits.
- Construction personnel would not interfere with wildlife. Firearms and pets are not permitted on the SAWSP site and no hunting, trapping or fishing would be allowed on SAWSP sites.
- Refuse would be disposed of at an approved landfill facility. Refuse stored on site prior to removal would be stored in closed containers.

Indirect Mortality

The following standard practices would be implemented to prevent or reduce the effects of indirect mortality to wildlife:

- The EPP directs an ECO Plan to include the identification of appropriate temporal windows for conducting work in areas where breeding migratory birds and species at risk are present (Appendices II and III). Appropriate setbacks would be set around locations where breeding wildlife is known to occur.
- Improper removal of beaver dams can result in the discharge of excessive amounts of sediment and water causing impacts on downstream fish and wildlife habitat. The Contractor would include relevant conditions from the necessary approvals into the ECO plan to prevent unplanned environmental damage.
- Appropriate ESC measures would be immediately applied when clearing vegetation where there is a risk of causing environmental damage to sensitive aquatic habitat. Areas used for the disposal of brush, timber or logs removed in the clearing operation would not obstruct drainage patterns and runoff from the disposal areas would not cause siltation of any streams or wetlands.
- A buffer of undisturbed vegetation would be retained between the construction site and watercourse to reduce the potential for sedimentation. The buffer would be fenced using silt fence or a similar barrier, to prevent equipment and machinery from encroaching into sensitive riparian habitat.

Monitoring Requirements

The mitigation policies noted above are designed to reduce or remove the predicted adverse environmental effects to wildlife. Direct monitoring of potential effects during construction and operations are not required. Adherence to the mitigation strategies, along with incidental observations made during the construction and long-term monitoring of aquatic habitat, is predicted to provide suitable opportunities to determine if the effects of the SAWSP have significantly affected wildlife. Effects related to changes to riparian zones, sediment control and habitat change within watercourses and bodies of water, physical barriers, and revegetation are to be monitored during the construction and initial operation of the SAWSP components under other disciplines such as surface water, aquatic habitat and vegetation. Interactions with wildlife or collisions with wildlife would be reported to AEP. Regional-scale monitoring of wildlife populations would not be conducted as significant adverse effects are not predicted at a regional scale.

Construction Monitoring

Monitoring activities around aquatic systems suitable for wildlife would include, but would not be limited to the following:

- Clearing activities and disposal areas would be examined for evidence of erosion, siltation, or potential for erosion and siltation.
- ESC measures would be inspected to ensure they have been installed in an effective location and are in good working order.
- Waste management and hazardous material storage would be inspected to ensure compliance with regulations and the ECO Plan.
- Access roads would be inspected to ensure they are properly maintained.
- Water flow, levels, velocity and quality parameters (e.g. turbidity and suspended solids) would be monitored to ensure levels are within required limits.
- Environmental conditions would be monitored to make sure that regulatory requirements and Department specifications are being adhered to.
- Monitoring records would be maintained, and proposed changes and alterations would be discussed prior to implementation.
- Dust conditions would be monitored and appropriately handled.
- Records as required by any environmental authorization, permit, licence, approval, or the ECO Plan shall be kept on site.

Post Construction Monitoring

Post-construction monitoring may be required as a condition of regulatory authorizations/approvals and would be undertaken as part of the aquatic habitat monitoring as required. Inspection activities would be documented and would include recommendations for required interventions for significant effects to wildlife during the initial operation of the SAWSP.

Monitoring activities would include, but are not limited to the following:

- Habitat revegetation success along the ROW and reclaimed areas.
- Stream banks would be inspected for revegetation success and for evidence of instability and/or erosion.
- Permanent ESC would be inspected to ensure proper function.
- Road ditches and medians, river valley escarpments and road embankments would be monitored for evidence of erosion.
- Reservoir and MUP performance as aquatic and wildlife habitat would be reviewed.
- Observations or reports of wildlife in canals would be documented.
- Observations or reports of incidents between wildlife and physical barriers would be documented.

1.3.10 Land Use and Management

Potential Project Effects

Potential effects of the SAWSP on land use and management include:

- access to land;
- changes to livestock and livestock management systems;
- disruption of perennial forage production and land capability;
- changes to annual crop production; and
- change in land use.

Access to Land and Water

Access to land during construction may become temporarily impeded at locations where few roads exist and where options to circumnavigate construction sites may be in poor condition. These disruptions are expected to be short term and can be mitigated by alternate routes or temporary access points. Permanent SAWSP infrastructure, canal alignments, and increased presence of water in channels may require permanent changes to land access.

Changes to Livestock Management Systems

During the construction phase, impediments to land access, and the disturbance of construction noise and activity, may disrupt livestock movements and distribution. Temporal effects may include disruptions to breeding schedules. Access to water may be impeded or change where SAWSP components affect existing dugouts and other water collection systems. The operation of the SAWSP would lead to a decrease in grazing landcover where existing pasture is inundated, where water persists in historically ephemeral channels, and where canals are constructed. Physical barriers to livestock movements may be created by the presence of SAWSP infrastructure, canals, and flowing streams.

Disruption of Perennial Forage Production and Land Capability

Perennial forages crops disturbed by construction may take two growing seasons to recover. As with annual crop production, weeds and invasive species can affect productivity. Increased costs of weed control may affect overall agricultural revenue.

Changes to Annual Crop Production

The construction of SAWSP infrastructure may lead to temporary obstructions to crop production. During construction, arable land may be located within the footprint of open cuts, laydown areas, and temporary access roads. Permanent SAWSP infrastructure and areas of inundation may displace arable lands. However, the intent of the SAWSP is to increase water availability to irrigable land throughout the Special Areas.

Changes to crop production may also be affected by weeds and invasive species. Revenue from crop production can decrease with increased costs of weed control. The propagation of clubroot could affect on the production of canola. Clubroot is spread through soil transported between fields. It can be transferred by footwear, though is typically transported by equipment and vehicles. The highest risk of contamination occurs when there is bare soil exposed.

Change in Land Use

SAWSP infrastructure and/or inundation would result in a reduction of land available for cropland and grazing (Table 1.13). A displacement of annual cropland would be limited to less than 10 ha, with close to 2000 ha of grassland permanently displaced. However, there would be an expected gain of approximate 530 ha of land capable of producing perennial forage crops. That latter would see relatively large areas of expansion around MUPs, which is expected to more than offset the relatively small areas of perennial forage lands lost to inundation (Table 1.13). In addition to the gain perennial forage capability, the SAWSP would provide the water availability to increase irrigable lands by approximately 3200 ha (Volume I: Appendix I). The irrigated lands would increase the diversity of crops, lead to higher yields of annual crops and perennial feed, and increase stock watering availability which would lead to improved management of grazing grasslands.

Table 1.13 Predicted changes to land use with the proposed SAWSP components

Project Component	Annual Cropland Permanently Displaced (ha)	Grazing Grasslands Permanently Displaced (ha)	Net Change in Perennial Forage Land (ha)
Water Supply System	**0.00**	-0.48	-0.30
Lehman Reservoir	0.00	-532.63	-43.70
Oyen Tributary System	0.00	-510.53	-8.35
Craig Lake Bypass Canal and Diversion Headpond	0.00	-24.92	-5.40
Scaupshovel Bypass Canal and Diversion Headpond	0.00	-17.28	0.00
Antelope Lake Bypass Canal and Diversion Headpond	0.00	-73.47	0.00
Esther Hay Meadow Bypass Canal and Diversion Headpond	-7.26	-85.13	-7.43
BC-4 Fertility	0.00	-89.56	43.10
BC-5 Dale	0.00	-10.08	18.60
BC-7 Contracosta	0.00	-81.91	93.00
BC-8 Richdale	0.00	-17.42	0.00
SO-5-6 Motz	0.00	-13.75	4.40
SO-7 Mitchell	0.00	-4.17	-1.10
SO-10 Wingding	0.00	-3.35	0.08
SO-11 Scaupshovel	0.00	-42.69	31.11
SO-39 Esther Hay Meadow	-0.04	-269.03	223.30
CR-6 Craig Lake	0.00	-108.01	109.70
CR-8 Sneath	0.00	-1.14	1.10
CR-10 Peter	0.00	-3.25	2.00
CR-13 Loon Slough	0.00	-35.44	37.20
CR-14 Scoville	0.00	-40.90	29.89
Totals	**-7.30**	**-1965.14**	**+527.50**

Mitigation Strategies and Best Practice Guidelines

Access to Land and Water Mitigation Strategies

Road and Trail Access

Access to public and private roads and trails would be maintained as best possible throughout the construction phase (Appendix I: Table I-9). If roads must be closed, then appropriate detours would be maintained. Consultation with landowners regarding access requirements would be completed prior to the initiation of construction. Trails and roads are to be left in a condition equal to or better than existing conditions. Temporary access roads and trails are to be reclaimed.

Increased water presence and canals may create barriers to vehicles. To facilitate landowner/lessee access, one livestock / vehicle crossing would be provided per quarter section (Volume I: Appendix I). At Lehman Reservoir, two roads would need to be re-routed and one road would need to be raised and a causeway (bridge or culvert) provided (Volume I: Appendix I).

Field and Pasture Access

To reduce effects to agricultural practices and production, construction would occur in the winter when practical. Construction is best avoided between April and June when the probability of rutting soils is highest.

Access to fields would be maintained during construction. Temporary fences would be used to separate livestock from construction areas. Long-term road and trail access would be maintained with gates and access roads of suitable size to accommodate farm equipment. Access between pastures would be maintained by gates or cattle guards. Gates would be kept closed when cattle are in fields. Landowners would be asked to keep construction crews informed of the location of cattle herds.

Water crossing points would be large enough to accommodate four-wheel drive tractors and implements that are commonly transferred between fields. Crossing widths and requirements would be discussed with landowners prior to construction.

Livestock Distribution, Canals, and Channel Crossing

Increased water presence in channels and construction of canals may affect livestock distribution and movements. To facilitate livestock access, one livestock / vehicle crossing would be provided per quarter section (Volume I: Appendix I). Crossings may be provided in various forms:

- Hardened Access Points – Fords of rock and gravel packed into the base of the channel that would allow livestock to walk across the channel and access water. Hardened access points are relatively inexpensive and encourage livestock to avoid other areas of the channel where trampling of soils and vegetation may occur.
- Culverts – Corrugated steel pipe (CSP) culverts up to 1,400 mm in diameter may be installed to develop crossings over canals and channels (Volume I: Appendix I). These crossings may be suitable for both equipment and livestock. A CSP culvert crossing are suitable for areas where banks of the channel/canal are steep or it is desired to keep the livestock out of the water completely. The width would allow for both safe livestock and equipment crossing.
- Bridges – The width of canals may require bridge crossings. Fences and rails may be required to allow safe cattle movements across a bridge.

Livestock Management Mitigation Strategies

Watering Locations

Historically, cattle accessed stagnant pools and dugouts located within the stream channel that would see increased flows and volume. Canals may obstruct livestock from watering locations. Where existing stockwatering locations become unavailable, stockwatering turnouts to dugouts would be provided at strategic locations. The locations of turnouts would be negotiated with landowners.

Fencing and Access Limitations

Fencing would be provided on both sides of canals to prevent damage by livestock. Landowner concerns/issues would be mitigated through the provision of one livestock/vehicle crossing per quarter section.

Gates and Crossings

Crossings and access points would have gates maintained during construction to prevent disruptions to livestock management. Cattle guards would be installed to reduce human livestock conflict where frequent vehicle use occurs through a field. Consultation with landowners regarding access requirements and herd management would be completed prior to the initiation of construction. Gates and existing cattle guards are to be left in a condition equal to or better than existing conditions.

Winter Construction

Construction during the winter would potentially lead to less conflict between livestock and construction activity. Cattle generally winter on smaller areas relative to summer. Disturbance of breeding livestock has the potential to affect livestock behavior and could lead to a decrease in productivity. Consultation would be conducted with potentially affected landowners or lease holders to review their proposed breeding schedule relative to the construction timelines. Construction during the winter would also allow for reclamation to occur the following spring, reducing the time the land would be unavailable for production.

Annual and Perennial Crop Production Mitigation Strategies

Landowner Consultation

Prior to construction and/or mitigation activities, landowners would be consulted to determine whether any construction and mitigation practices may conflict with existing crop management. Conflicts would be resolved prior to ground disturbance.

Invasive Species Mitigation Strategy

Prior to construction the pre-disturbance assessment would identify invasive species of concern. Species of concern include regulated weeds. Mitigation would focus on the BMPs outlined in AT’s Civil Works Master Specifications (Appendix IV) 01391-1.3.2.1-1.3.2.6 and the mitigation strategies below.

Pest Control

Periodic pest surveys would need to be conducted to determine if any control measures need to be implemented. The timing of the surveys and the pest species of concern can be determined by referring with an agrologist in consultation with landowners. Once the surveys have been completed, control measures can be determined if necessary.

Clubroot is listed under the Alberta *Agricultural Pests Act* (R.S.A. 2000, c. A-8) as a declared pest. The regulations for the control of clubroot is enforced by municipalities. There are no fungicides available to control for or stop the spread of clubroot. Mitigation would be the prevention of further spread of the disease. In areas where clubroot may be a concern, soils would be sampled in accordance to protocols provided by Alberta Agriculture and Forestry. BMPs include (Government of Alberta 2014):

- Minimize equipment and vehicle traffic between fields.
- Where fields are lightly infested near access points, create a new exit at an alternative, distant edge of the field if possible.
- Avoid the use of straw, hay or manure from infested or suspicious areas.
- Equipment and Vehicle Cleaning - Any equipment used in areas where clubroot has been found, or has the potential to be found, should be cleaned prior to exiting a contaminated site. For areas of high risk, steps to be followed include:
  - Removal of soil lumps from equipment and vehicles with a power washer.
  - Mist equipment with disinfectant. Recommended products include 1 to 2 per cent active ingredient bleach solution, HyperOx or EcoClear. The use of a disinfectant without first removing soil is not recommended because soil inactivates most disinfectants. A twenty to thirty-minute wet period is necessary for good efficacy.
  - Disposable foot coverings should be utilized where possible and in combination with a disinfectant foot bath.

Seeding

Unless otherwise directed by a landowner, seed mixes would be formulated to match the surrounding plant community type or crop. For best results, seeding would occur either in spring or late fall. If seeding during this time is not possible, a temporary cover would be seeded to reduce the risk of soil erosion. A professional agrologist, in consultation with landowners, would provide guidance for acceptable seed mixes and seeding protocols for specific site conditions.

Vegetation Management

Vegetation management may be required where land is used for grazing. Reclaimed areas would be fenced to prevent grazing in newly seeded areas, along with damage from hoof shearing or compaction. Fencing would remain place until vegetation has reached a point where grazing would no longer impede the sustainability of the vegetation (generally two to three years). The fencing would subsequently be removed unless the landowner requests it to remain place.

Change in Land Use

Upland areas inundated at reservoirs would lead to a displacement of agricultural lands. Remuneration for the loss of productive land would be negotiated with landowners or leaseholders. Increased water availability would be factored into negotiations.

1.3.11 Infrastructure

Potential Project Effects

The Baseline Conditions for infrastructure are discussed in the ECS (Volume I: Appendix I). The SAWSP consists of long, linear components (i.e. pipelines, powerlines, canals, creeks, and access roads), water impoundments (water supply reservoirs and MUPs) and local infrastructure (main and booster pump stations) (Table 1.14). Existing infrastructure includes roads, trails, railroads, farmsteads, residential areas and underground utilities (oil and gas pipelines and communications) (Digital Map Package).

Potential effects of the SAWSP on infrastructure include:

- access to existing infrastructure;
- disruption of utilities; and
- displacement of existing infrastructure.

Access to infrastructure during construction may become temporarily impeded at locations where few roads exist and where options to circumnavigate construction sites may be limited. Disruption of electricity during the winter can disrupt watering to livestock and cause water tanks to freeze. Telecommunication lines could be damaged and result in local disruptions to communication.

Permanent physical barriers to infrastructure may be created by the construction of SAWSP such as the canals. Moving access roads would require regulatory approvals for industry to obtain locations for new lease access roads. Existing roads may require reclamation upon completion of new alternate road access.

Daylighting buried infrastructure may reveal contaminated soils and could introduce requirements for remediation. A high concentration of pipelines and wells are found adjacent to Antelope Lake and the proposed bypass canal (Digital Map Package).

Table 1.14 Infrastructure Potentially Affected by SAWSP Components

SAWSP Component		Farmstead/ Approach	Roads				Railroads	Oil and Gas Pipelines					Phone	Dam / Reservoir
			Major/ Paved	Minor/ Paved	Gravel	Trail/ Cart Path		Dia >500 mm	200<Dia <500	120<Dia <200	Dia<120	Unknown		
Water Supply System		20	2	2	49	25	1	0	11	21	40	3	0	0
Lehman Reservoir	Lehman Reservoir	0	0	0	3	0	0	0	0	1	6	0	1	0
	Berry Creek Inlet Canal	0	0	0	1	5	0	0	0	3	9	2	0	0
	Craig Lake Tributary Dam and Inlet Canal	0	0	0	1	0	0	0	0	1	2	0	0	0
	Craig Lake Tributary	0	0	1	1	8	0	0	2	2	12	0	0	0
Oyen Tributary System	Oyen Tributary Reservoir	0	0	0	1	3	0	1	1	0	4	0	0	0
	Diversion Dam Reservoir	0	0	0	0	0	0	0	0	0	0	0	0	0
	Oyen Tributary Canal	0	0	1	1	2	0	0	0	2	5	0	0	0
	Sounding Creek Reservoir	0	0	0	0	0	0	0	0	0	0	0	0	0
Craig Lake Bypass Canal		0	0	0	0	2	0	0	0	1	5	1	0	0
Scaupshovel Bypass Canal		0	0	0	1	1	0	0	0	0	3	0	0	0
Antelope Lake Bypass Canal		0	0	0	0	1	0	0	0	0	15	2	0	0
Esther Hay Meadow Bypass Canal		0	0	0	2	4	0	0	0	1	6	0	0	0
Berry Creek MUPs		1	0	0	0	7	0	0	0	0	0	0	0	0
Craig Lake Multi-Use Projects		0	0	0	0	0	0	0	0	2	0	0	0	0
Sounding Creek MUPs		0	0	0	0	2	0	0	0	0	0	0	0	0
Berry Creek		2	1	0	8	6	1	0	7	6	24	2	8	1
Sounding Creek		0	1	2	15	31	0	2	6	16	45	0	5	4
Total:		**23**	**4**	**6**	**83**	**97**	**2**	**3**	**27**	**56**	**176**	**10**	**14**	**5**

Mitigation Strategies and Best Practice Guidelines

It is assumed that all road crossings, except Highways 36 and 56, and the farmstead approaches would be open cut. Road detours or alternate access would need to be provided during construction. For Highways 36 and 56, the pipeline would be installed using trenchless technology.

There are many existing road crossings on Sounding Creek, Berry Creek, and the Craig Lake Tributary (48 crossings on Sounding Creek, 15 crossings on Berry Creek, and 10 on the Craig Lake Tributary) (Table 1.14). It is assumed that these road crossings would need to be updated as the crossings are likely undersized to convey the SAWSP design discharge. New culvert crossings would be constructed where 12 existing roads intersect the proposed inlet canal and bypass canal alignments (Appendix I: Table I-10).

Rerouting some roads would be required due to inundation. Three gravel road would be inundated at Lehman Reservoir, and one gravel road and three trails would be inundated at the Oyen Tributary Reservoir. Nine trails are expected to be inundated by MUPs and would require rerouting. A causeway culvert would be required at MUP SO-5/6 Motz due to an inundated gravel road.

Data for pipeline alignments (Digital Map Package) were obtained in 2012 (Volume I: Appendix I). The WSS pipeline would cross 75 pipelines (Table 1.14). It is assumed that oil and gas pipelines would be hand-exposed and temporarily supported to allow the water supply pipeline to be constructed underneath. Sixty-nine, 39, and 16 pipelines currently cross Sounding Creek, Berry Creek, and the Craig Lake Tributary, respectively. It is assumed that these pipelines can be operated when submerged below creek flows and relocation or modification to the pipelines (i.e. weighting, anchoring, etc.) is not required (Volume I: Appendix I). It is recommended that the pipeline crossings be monitored as the creeks adapt to the introduced, diversion discharge to monitor that channel adaptation including erosion does not affect pipeline integrity. For canals, it is assumed that the pipeline would be extended and relocated to be a minimum of 1 m below the canal invert. It is assumed that pipelines inundated within Lehman Reservoir, the Oyen Tributary Reservoir, and the MUPs can be operated in an inundated condition and relocation or modification (i.e. deeper burial, pipeline relocation, or ballast) is not required. This needs to be confirmed in future phases of design (Volume I: Appendix I).

There are four small existing dams and reservoirs located on Sounding Creek and one located on Berry Creek (Digital Map Package). These dams are not included in the core project works but would need to be rehabilitated or decommissioned so that the diversion discharge can be safely conveyed through or around the reservoirs. It is assumed that an overflow weir structure and channel could be constructed to safely convey the diversion discharge through these reservoirs; however, this should be confirmed in further phases of design (Volume I: Appendix I).

Other infrastructure includes railways and telecommunication lines. Two railroad crossings would be required along the WSS and would require trenchless technology. There are 14 buried telephone lines that could be affected by the SAWSP. It was assumed that the telecommunication lines could be inundated without additional mitigation (Volume I: Appendix I). Disruptions to utilities are expected to be short term and can be mitigated by avoidance or temporary bypasses.

1.3.12 Historical Resources

Potential Project Effects

Since pre-contact archaeological, historical, palaeontological and traditional land use sites represent discrete episodes of past activities, they are non-renewable and are susceptible to alteration or removal by development. Pre-contact and historical archaeological resources are composed of residues of past cultures. Although the cultural entities responsible for deposition of the archaeological material are unavailable for observation, the preserved context and associations in which the remains functioned can reveal many clues about past human behaviour, adaptations and relationships to the natural world.

The key to the interpretation of these resources, however, is in their pattern of cultural deposition, which is extremely fragile, ephemeral and the product of unique processes and conditions of preservation. Consequently, once they are disturbed, they cannot be replaced, recreated or restored. Due to the nature of their origin and preservation, archaeological resources are finite in quantity. As a result, archaeological resources are increasingly susceptible to destruction and depletion through natural and cultural disturbances.

Based on the impact of the development and operation of the SAWSP, the potential effects of the SAWSP on historical resources include:

- direct disturbance of historical resource sites;
- indirect disturbance of historical resources sites due to inundation; and
- indirect disturbance of historical resources sites due to erosion and exposure.

Mitigation Strategies and Best Practice Guidelines

Adverse primary impacts to historical resource sites, identified prior to the construction stage of development, can be significantly reduced or eliminated by avoidance or adequate study (Appendix I: Table I-11). Site avoidance can be achieved through alteration of the SAWSP footprint. If avoidance is not feasible, adequate study of historical resource sites generally involves scientific investigations as per Section 37 of the *Historical Resources Act* (R.S.A. 2000, c. H-9) that are designed to systematically explore and reconstruct the activities that are represented at the site. These investigations may involve the systematic collection of surface site materials, detailed mapping, photographic documentation of sites, or the excavation of buried sites. In cases where the heritage value of an archaeological site is low, photographic documentation, recording, and collection of surface specimens may represent sufficient mitigative measures. In cases where the heritage value of an historical resource site is identified as high, more detailed investigative measures, such as controlled excavation, may be necessary.

It is further recommended that a long term historical resources management program be implemented to allow for site-specific mitigation activities to take place in advance of both direct (construction) impacts but also in advance of erosion related impacts. The management plan would consider impacts to known archaeological sites but would also consider periodic monitoring (at regular intervals, and after major flood events) that would allow for unrecorded archaeological sites to be identified if they are exposed over time by erosion, and impacts mitigated. It is expected that this management plan would need to be in place for decades, and continuously modified as the effects of the SAWSP change and expand.

1.3.13 Summary of the General Environmental Impact of the SAWSP System

The SAWSP would be constructed by component. The potential effects related to construction is expected to be constrained to the local, component level. However, as a system, the operation of the SAWSP would have effects that could be measureable at a regional scale.

At a regional level, significant effects of noise and to air quality are not predicted (Appendix I: Table I-1). Mitigation strategies would be employed to control dust generated from construction sites. Emissions from construction vehicles is expected at a local scale but would be a temporary effect. Relavent to existing ambient noise levels, the construction of the SAWSP would temporarily increasenoise levels at a local scale. The pumphouses are expected to contain noise levels, thus no significant increase in noise is expected.

Significant changes to regional water quality and water quanity are expected (Appendix I: Tables I-2 and I-3). The intention of the SAWSP would be to provide the Special Areas with a more reliable source of water, water that is of higher quality with respect to the existing sources.

Due to the increased presesnse of water in stream channels and water bodies (reservoirs, headponds, MUPs), the SAWPS would lead to increased groundwater recharge (Appendix I: Table I-4). The groundwater is expected to improve in quality relative to the existing groundwater, though the effect is expected to be negligible at regional and local scales.

At a regional scale, improvement to habitat suitability and availability is expected for forage fish, both in flowing water and ponded water (Appendix L: Table I-5). Expansion of forage fish populations may occur throughout the SAWSP. An increase in benthic and planktonic invertebrate productivity would provide increased availability of food for forage fish. No increase in presence of sport fish is expected at a regional level, as barriers to regional movements of sport fish would remain throughout the SAWSP and sport fish would only be introduced in major reservoirs. Potentially harmful effects to aquatic habitat, such as the release of deleterious substances or sediment would be controlled through best management practices and mitigation strategies.

Mitigation strategies and best management practices applied towards soil conservation at a local level are expected to prevent regional scale, adverse effects to soils (Appendix L: Table I-6). With appropriate erosion control measures, soil salvage and handling plans, significant adverse effects to soils would not be expected at local and regional levels. With the introduction of a reliable water source and expanded irrigation, an improvement in soil capability would be expected at a regional scale.

The displacement of native prairie due to inundation is expected at most components. At a regional scale, the availability of native praire is extensive and local reductions are not expected to lead to significant change to regional availbiility of native prairie grassland. Pre-disturbance surveys would be conducted for rare plant occurrence (Appendix I: Table I-7). Should a species be detetermined to be of concern at a regional level, avoidance of the species would be the primary mitigation. If avoidance is not possible, the collection of the species for transplanting or seeds for future plantings would be conducted. The loss of rare species is not expected at a regional level. As per the *Water Act*, pre-disturbance wetland assessments would be conducted to determine the potential loss of wetlands habitat at a local scale. Wetland habitat gained through the development of the SAWSP at a regional scale would be used to offset wetlands lost to infrastructure or inundation. A net increase in wetland habitat is expected at a regional scale.

As noted above, the displacement of native prairie due to inundation is expected at most components. At a regional scale, the availability of native praire, which is considred to be optimal highly suitable habitat for numerous species of wildlife designated as of conservation concern, would remain extensive at a regional scale (Appendix ITable I-8). Local reductions in native prairie would not be expected to cause significant change to regional sustainability of wildlife populations. An increase in the availability of habitat for aquatic and semi aquatic wildlife would be expected, though it would not likely significantly influence the sustainability of wildlife populations at a regionl scale. Direct and indirect mortality of wildlife would be mitigated through the implementation of best management practices.

The SAWSP is intented to change land use at a local scale through the increased provision of water at irrigable lands. Agricultural practices would change at locations where irrigation would be made possible through an increased and reliable water supply (Appendix I: Table I-9). At a regional scale, the improved quantity and quality of water for crop production and stock watering throughout the benefiting area expected to contribute to regional production and land value. However, the socio-economic assessment suggests regional change would not be significant (Volume III). Changes to land / pasture access due to the footprint of the SAWSP, along with a loss of grazing lands to indunation would occur at a local scale. A significant change to land use would not be expected in the Special Areas region.

At a local scale, access impedences would occur to existing infrastructure such as utilities, oil and gas infrastructure, and roadways (Appendix I: I-10). The impedences would be temporary, would be avoided using trenchless construction techniques, or would require permanent rerouting. Significant regional effects to infrastructure would not be expected.

Many of the SAWSP components are proposed in areas with high probability of historical resources (Appendix L: Table I-11). As per the Historical Resources review conducted by Alberta Culture and Tourism (Appendix VII), Historical Resources Impact Assessments (HRIA) would be conducted prior to ground disturbance or indunation to determine if significant historical resources would be affected. The loss of regionally significant archaeological and palaeontological would be prevented by avoidance, or documentation, and / or recovery of historical resources.