Volume 2, Section 14 Snake Lake Reservoir Expansion Project
Environmental Impact Assessment
Historic Resources

Submitted to:

MPE
a division of Englobe

MPE
A division of Englobe,
Lethbridge, Alberta

On Behalf of:

Eastern Irrigation District
Brooks, Alberta

Submitted by:

AAR Environmental Services
Calgary, Alberta

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Executive Summary

The Eastern Irrigation District (EID) is applying for approval under the *Environmental Protection and Enhancement Act* (EPEA) to construct the proposed Snake Lake Reservoir (SLR) Expansion Project (the Project). The Project, located between Bassano and Brooks in Alberta, involves the construction of a roughly 8 km long, up to 20 m high dam to increase the storage capacity of the reservoir system from 19.25 million m^3 to 87.4 million m^3. This Environmental Impact Assessment (EIA) section includes a baseline assessment, which contains details on historic resources in local and regional study areas, based on requirements provided in the Final Terms of Reference (FTOR; Volume 2, Appendix A) for the Project issued by Alberta Environment and Protected Areas (Alberta EPA), and following the Guide to Preparing Environmental Impact Assessments in Alberta. This document also contains residual impacts. A cumulative effects assessment (CEA) was not completed for historic resources.

Archaeological Summary:

Following the referral of this Project by the EID, a Historic Resources Application was made to Alberta Arts, Culture and Status of Women (ACSW). A signed requirement letter was subsequently issued (Historic Resources Management Branch File No. 4825-21-0010-001) which called for a Historic Resources Impact Assessment (HRIA) for all areas of high archaeological potential. An Archaeological Research Permit Application was made to ACSW and Permit No. 2021-073 was subsequently issued on June 10, 2021. Fieldwork was completed between June 14 and June 30, 2021, using standard survey techniques involving pedestrian traverses, visual inspection of the ground surface and subsurface (hand shovel and mechanical excavator) testing of the proposed development area.

Several datasets available through the Heritage Resource Management Branch (HRMB) of ACSW were consulted to derive a baseline understanding of known historic resource sites within and near the Project footprint. One previously discovered archaeological site, EdPb-20, was revisited during the HRIA. The subsurface testing program included a total of 564 shovel tests and 5 mechanical deep tests within the local study area (LSA). It also consisted of a pedestrian survey including the investigation of 908 subsurface exposures within the proposed impact area. Twelve shovel tests were positive for cultural material, as were 47 exposures. As a result, 22 new archaeological sites were recorded within the Project footprint. These sites represented both large artifact scatters (>10 artifacts) and small artifact scatters (<10 artifacts), as well as two stone feature sites.

Results of the HRIA were submitted to ACSW in the form of a Final Report, which included avoidance and mitigation recommendations for those archaeological sites with significant historic resource value. After review of the HRIA Final Report (Permit No. 2021-073), ACSW produced stage-one mitigative excavation requirements for EdPb-28 and EdPb-39 in May 2022.

Recommendation for no further work associated with historic resource values (HRV) 0 sites was also accepted by ACSW. Consequently, reservoir expansion would be allowed to proceed around those sites. The sites with no further work required, based on the HRIA recommendations, were EdPb-20 through 27, 29 through 38, and 40 through 45. *Historical Resources Act* (HRA) clearance was recommended for the Project footprint submitted in conjunction with the Final Report. Consequently, additional temporary workspace and storage locations will require a Historic Resources Amendment to update the HRA clearance for all Project areas.

Palaeontological Summary:

After conducting a palaeontological Historic Resources Impact Assessment for the Snake Lake Reservoir Expansion Project (the Project) in accordance with the Schedule of Requirements issued by Alberta Culture and Tourism (ACT File: 4825-21-0010-001), the following conclusions and recommendations are made for the Project to preserve palaeontological resources, mitigate any possible impact to them, and remain in compliance with the *Historical Resources Act* requirements:

1. The pedestrian survey noted 18 new fossil sites (see Plate 14-3 to Plate 14-20: Snake Lake Sites 1-18; Table 2) along the Project footprint. Important fossils were recovered from 12 of 18 sites (Sites 1, 2, 4, 5, 7-9, 12, 13, 15, 17, and 18). Fossil resources were observed at, but not collected from, the 6 remaining sites (Sites 3, 6, 10, 11, 14, and 16; fossil plant debris, feeding or burrowing trace fossils, unidentified fossil baculitid shell, unidentified fossil ammonite shell, unidentified fossil fish vertebra, *Bos taurus* skull and vertebra, *Canis latrans* dentaries, and *Erethizon dorsatum* dentary). Specimens include Cretaceous fossil ammonite (*Placenticeras intercalare*, *Placenticeras meeki*, *Placenticeras* sp., Scaphitidae indet., Baculitidae indet., Ammonitida indet., and unidentified) shell fragments and body cavity, bivalve (unidentified) shell fragments, bryozoan (*Membranipora* sp. and Cheilostomatida indet.) colonies, fish (*Squalicorax* cf. *S. kaupi* and *Osteichthyes indet.* [boney fish]) tooth and vertebra, plant (unidentified) leaf, wood, and debris, unidentified feeding or burrowing trace fossils, and Quaternary mammalian (*Bos taurus* [domestic cow], *Canis latrans* [coyote], and *Erethizon dorsatum* [porcupine]) skeletal material (skull, dentaries, and vertebra).
2. A strip of land 8.7 to 211 m wide will be grade cut to a stable base (bedrock) and depth will vary from 2 to 6 m on top of which will be constructed an earthen dam (with a total estimated footprint of approximately 452,000 m^2). Both Quaternary and bedrock deposits have a high potential to yield significant palaeontological resources along the eastern and northeastern areas of the proposed dam footprint in this area. Deep grade-cutting activities for the dam footprint also have the potential to affect the underlying fossil-rich Bearpaw Formation shale. As per the Historical Resources Application Act Approval, excavation activities and grade cuts in these areas require a monitoring program.
3. In addition, if some of the borrow-source clay-till is not suitable and bedrock (i.e., weathered Bearpaw Formation shale) is required to construct the earthen dam, it will likely be retrieved from the central area of ‘Borrow Source A2’. If this is the case, excavations into weathered shale could be up to 3 m deep. A monitoring program is recommended for 'Borrow Area A2’ (and any other borrow source areas) that will affect weathered and unweathered bedrock of the Bearpaw Formation.

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Field Photographs

Abbreviations

ACSW	Alberta Arts, Culture and Status of Women
AEPA	Alberta EPA
BCE	Before Common Era
BP	Before Present
ca.	Circa
CEA	Cumulative Effects Assessment
EIA	Environmental Impact Assessment
EID	Eastern Irrigation District
EPEA	*Environmental Protection and Enhancement Act*
FBR	Fire-broken rock
FTOR	Final Terms of Reference
GOA	Government of Alberta
GIS	Geographic Information System
HLSA	Historic Resources Local Study Area
HRA	*Historical Resources Act*
HRIA	Historic Resource Impact Assessments
HRIM	Historic Resources Impact Mitigation
HRMB	Historic Resources Management Branch
HRSA	Historic Resources Regional Study Area
HRV	Historic Resource Value
LiDAR	Light Detection and Ranging
LSD	Legal Subdivision
RTMP	Royal Tyrrell Museum of Palaeontology
SLR	Snake Lake Reservoir

14.1 INTRODUCTION

14.1.1 Background

The Eastern Irrigation District (EID) is applying for approval under the *Environmental Protection and Enhancement Act* (EPEA) to construct the proposed Snake Lake Reservoir (SLR) Expansion Project (the Project). The Project, located between Bassano and Brooks in Alberta, involves the construction of a roughly 8 km long, up to 20 m high dam to increase the storage capacity of the reservoir system from 19.25 million m^3 to 87.4 million m^3. The Project will inundate all or portions of Sections 29, 30, 31, and 32-19-16 W4M in the County of Newell, developing approximately 827 ha of land east of the existing reservoir (Appendix L1, Figure L1-1).

Most of the basin will be excavated, so the new reservoir will hold water both below and above the natural elevation. Aggregate and granular materials will need to be sourced, including gravel for potential drainage chimneys and finger drains and riprap and bedding gravel for erosion protection. Sands and gravels are relatively abundant within the County of Newell; however, riprap is not readily available. EID is currently investigating a riprap source from a quarry south of the Project. A new low-level outlet structure will be constructed at the north end of the expanded reservoir to deliver water to the existing Springhill Canal system via the Snake Lake Canal.

The reservoir expansion will provide additional water security during droughts, when direct river withdrawals cannot be maintained (i.e., when river waters run low in later summer/fall and when most or all water is needed to meet instream flow needs for the protection of aquatic life in the Bow River). As part of the approval process, this section of the Environmental Impact Assessment (EIA) examines historic resources (archaeological and palaeontological materials) and the effects the Project will have on these resources. For the purposes of data collection and analysis, the Historic Resources Local Study Area (HLSA), roughly follows the reservoir expansion area (Figure L1-1). A Historic Regional Study Area (HRSA) is limited to a 1 km buffer around the HLSA, but is of limited utility given discrete management of these resources within ‘sites’ that rarely exceed the distribution boundary of the physical material.

14.1.2 Purpose

Historic resources refer to natural or anthropogenic features or objects with palaeontological, archeological, prehistoric, historic, cultural, natural, scientific, or aesthetic value (Government of Alberta [GOA], 2000). This investigation focuses on palaeontological and archaeological resources present within the Project area and potential effects on these resources. Historic resources are non-renewable and can be affected through human actions and natural processes such as erosion. The cultural and scientific value of these resources is managed by Alberta Arts, Culture and Status of Women (ACSW) through processes of desktop assessment, impact assessment, and impact mitigation.

The Project, once constructed, will be a permanent 827 ha feature on the landscape and will affect cultural resource-bearing soils and bedrock. To determine whether the Project could affect historic resources; impact assessments were performed for archaeological and palaeontological resources within the footprint. Project activities have the potential to displace, destroy, or bury such resources.

The purpose of this baseline is to ensure that the Project will not cause significant loss of cultural and scientific information as it is represented by historic resources. This will require delineation and a description of previously identified archaeological and palaeontological sites and areas of potential where artifacts could be found within the planned Project footprint. Resources and areas of high potential were determined by consulting the October 2021 Listing of Historic Resources (GOA, 2021), literature searches, and communication with researchers and staff of the Royal Tyrrell Museum of Palaeontology (RTMP) and the Royal Alberta Museum.

The effects assessment on historic resources will be completed following the Final Terms of Reference (FTOR; Volume 2, Appendix A) for this EIA report. The Guide to Preparing Environmental Impact Assessment Reports in Alberta was also consulted to help refine this section (GOA, 2013).

14.1.3 Project Setting

The proposed Project is located within the Dry Mixedgrass Natural Subregion of the Grassland Natural Region of Alberta (Natural Regions Committee, 2006). The Dry Mixedgrass, the largest subregion within the Grassland Region, is situated in the southeast portion of the province. This subregion consists of level to gently rolling semi-arid prairie landscapes intermixed with coulees, valleys, badlands, and dune fields. Slopes range from level to very steep depending on the site landscape features such as coulee slopes, hills, hummocks, or dunes.

Climate of this subregion is warm and dry, with a mean annual temperature of 4.2°C. In summer, mean temperature is 18.5°C and in winter is -10.2°C. Mean annual precipitation is 333 mm, the lowest of any natural subregion in Alberta (Natural Regions Committee, 2006). Many native plants in the region are deep rooted and long lived or have developed physiological traits which allow them to assume a dormant condition during dry periods. Native grasslands in the natural subregion have been subject to land use change by agriculture including conversion to tame pasturelands, croplands, and irrigated croplands. Agriculture dominates land use, including grazing pastures in areas with low rainfall and poor soils, and crop cultivation in areas with suitable soils, including both dryland farming in areas with sufficient natural rainfall, and irrigated croplands in other areas. Other land uses and disturbances are less common but include industrial activities (e.g., oil and gas), intensive farming operations, transportation infrastructure and residential uses. Natural water systems have been supplemented by the development of a system of reservoirs and canals to support irrigation.

Within the Project footprint, livestock grazing was the dominant agricultural practice up until 2022 resulting in a land surface with incised cattle trails, pugging in wetland areas and bare soil/erosional areas where cattle congregated. Dugouts and ditches have been developed throughout the Project area to provide water for cattle.

Topography in the Project area is typically gentle and undulating with slopes less than 5%. Overall, there is a gradual slope to the east (<1%) with a high point of 770 m and a low point of 760 m (Atkinson, et al., 2020). Slightly to very stony, loam to clay loam textured till is the dominant surficial material occupying about 85% of the Project area. Most of the till (63%) is moderately to strongly saline and sodic especially in low lying areas. The remaining 15% consists of glaciofluvial sands and gravels as well as glaciofluvial sands overlying loam to clay loam textured till (Atkinson, et al., 2020). The glaciofluvial sand and gravel areas, largely confined to the eastern side of the

Project, are non-saline and non-sodic while the underlying till is usually moderately to strongly saline and sodic. Gently to moderately rolling ridges with slopes up to 15% occur adjacent to a central meltwater channel. The till on these steeper slopes is usually moderately to very stony (Atkinson, et al., 2020). Significant areas of poorly drained, level to depressional areas occur in wetlands and other water bodies throughout the study area. Most of these are strongly saline and sodic at the surface.

The dominant soil types found in the Dry Mixedgrass Natural Subregion include Brown Chernozemic and Solonetzic soils. Cultivated lands typically have 5 to 10% calcareous eroded knolls with Regosolic or Rego Chernozemic soils. A mixture of Humic, Orthic, and Luvic Gleysols can be found in wetlands. Surface conditions are extremely saline with salt crusts surrounding wetland and waterbody margins and hardpan conditions.

Bedrock mapping shows the Project site occurs within the Bearpaw Formation, which consists of marine to marginal marine deposits comprised of dark grey, blocky shale and silty shale, greenish (glauconitic) and grey, clayey sandstone, and thin concretionary sideritic and bentonite layers with concretions that locally yield ammonites. Surficial sediments in the development area are comprised of Quaternary deposits of fluvial silt, sand, and gravel (fluvial, glaciolacustrine and stagnant ice moraine) (Prior, et al., 2013). A palaeovalley thalweg is mapped to the immediate northeast of the Project footprint suggesting in situ and reworked pre-glacial and interglacial gravels may be present within the Project footprint. ‘Pre-glacial’ (Empress Formation) and Quaternary post-glacial gravel deposits across this region of the province are known to contain significant ‘ice-age’ mammal remains. The Empress Formation (‘Saskatchewan Gravels’) are Late Wisconsinan Pleistocene interglacial (pre-late glacial maximum) sand and gravel deposits known to contain significant Pleistocene vertebrate remains.

The Project area lies within the Northwestern Plains cultural area, which has experienced continual human presence over the last 13,000 years (Peck, 2011). Since the first European expeditions into this area did not occur until the eighteenth century, most of this period belongs to nomadic and semi-nomadic hunter-gatherers, and their material remains compose most of the archaeological record in Alberta. The prehistoric period is typically divided into three distinct sub-periods: Early (11,050-7,500 Before Present [BP]), Middle (8,300-1,350 BP), and Late Prehistoric (1,500-300 BP), with overlapping transitions between each period. The prehistoric periods are followed by the protohistoric (300 to circa [ca.] 200 BP) and historic periods (ca. 200 BP to present) that see the introduction of European material culture and influence.

Radiocarbon dated material from a nearby recorded archaeological site (EdPb-39) suggests the site was occupied and used as a campsite during the late Middle Prehistoric period, which would associate it with the Besant phase. The Middle Prehistoric Period begins with the Country Hills Complex and ends with the Besant Phase. The beginning of this period coincides with a climatic event known as the Hypsithermal, from about 7,000 BCE to 500 BCE, where warmer and drier conditions caused a northward shift in the boundaries of the major ecozones of Alberta (Vance 1991). This period was distinguished by the introduction of a new hunting technology, the atlatl, or spear thrower. Projectile points are smaller than the preceding period, and they are also notched for the first time.

Middle Prehistoric sites demonstrate a Plains-adaptation strategy that persisted through the remainder of prehistory (Reeves & Davis, 1990). The most impressive of these was the use of large-scale communal hunting methods, as can be seen by the first ever use of Head-Smashed-In Buffalo Jump by Mummy Cave groups (Reeves, 1978). Such hunting strategies created large meat surpluses that required long-term storage techniques. Quantities of fire-broken rock (FBR) are seen in this period for the first time, associated with boiling pits that were used to render grease from bones to make pemmican.

The Middle Prehistoric period also witnesses initial evidence of complex ceremonial activities, including the first use of the famous Majorville Medicine Wheel in southern Alberta by the Oxbow complex (Calder, 1977). It is also in this period that archaeologists have found the earliest evidence of tipi rings, which then became common around 5,000 years ago (Frison, 1991, p. 137).

14.1.4 Regulatory Information

Several regulations and guidelines exist for qualifying and mitigating adverse effects to historic resources in Alberta (Table 14-1). A Historic Resources Application was made to ACSW as part of the Project's application process. A signed requirement letter was subsequently issued (Historic Resources Management Branch File No. 4825-21-0010-001), which called for two Historic Resource Impact Assessments (HRIAs) for all areas of high archaeological and palaeontological potential.

An Archaeological Research Permit Application was made to ACSW and Permit No. 2021-073 was issued on June 10, 2021. All field work for the archaeological Historic Resources Impact Assessment (HRIA) was completed between June 14 and June 30, 2021, using standard survey techniques involving pedestrian traverses, visual inspection of the ground surface, and subsurface testing (by hand shovel) of the proposed development area. Whenever possible, opportunistic soil exposures, such as exploratory excavations as part of the geophysical site program, were inspected.

Applications for a Mitigative Palaeontological Permit (Permit to Excavate Palaeontological Resources) was submitted to the RTMP and a signed permit (Permit No.: 21-066) was received for the Project (GOA, 1998; 2000; 2002). A field pre-impact survey of the Project area was completed on August 13, 18, and 21, 2021 and September 9, 2021. This survey was completed using pedestrian reconnaissance of the Project lands.

On January 24, 2025, the EID received a *Historical Resources Act* Approval with Conditions from ACSW (HRA Number: 4825-21-0010-003). The Approval applies to the development areas that were known at the time of submission, which excluded the outer boundary and the soil storage area. Appendix L1, Figure L1-1 and Figure L1-2 depict the initial survey area in green. To include this outer boundary and soil storage area, an additional clearance application was submitted to ACSW on March 14, 2025. Appendix L1, Figure L1-3 depicts the additional area that is awaiting approval.

Table 14-1: Regulations and guidelines for assessment and protection of historic resources in Alberta

Regulation or Guideline	Context
Historical Resources Act (HRA)	Provides for the use, designation and protection of historic resources, including palaeontological, archaeological, historic or natural sites, structures or objects (GOA, 2000). Provides mechanisms for designating provincial or municipal historic resources, establishing provincial or municipal historic areas, and naming geographical features. Governs research permits, title to archaeological and palaeontological resources, and transport of historic resources out of Alberta.
Alberta Listing of Historic Resources	The listing of historic resources identifies lands that contain or are believed to contain historic resources, including primarily archaeological and palaeontological sites, indigenous traditional use sites of a historic resource nature, and historic structures. Issued twice a year, it provides industry and other developers with advance notification of possible historic resource concerns.
Archaeological and Palaeontological Research Permit Regulation	Provides the means for applying for an archaeological or palaeontological research permit as well as defines conditions of use (GOA, 2002).
Guidelines for Archaeological Permit Holders	This is a collection of survey notes, information bulletins, guidance documents and standards related to various aspects of site assessment, recording, reporting, data submission, and materials curation. These documents are an evolving collection that receives periodic updates and additions (Archaeological Survey of Alberta, 1989).

14.2 STUDY AREAS

Baseline conditions and potential Project effects were qualified at both a local (Project-specific) scale and a regional (cumulative effects) scale by examining resources or indicators in a Local and Regional Study Area (Appendix L1, Figure L1-1). The study areas for historic resources were defined as:

- Historic Resources Local Study Area (HLSA) – reservoir expansion boundary (i.e., Project footprint).
- Historic Resources Regional Study Area (HRSA) – reservoir expansion boundary + 1 km buffer.

At the time of HRIA clearance application, the Project footprint was preliminary. Since the time of application, the Project footprint been updated. The footprint, and maps in this Historic Resources section reflect what was studied at the time of the HRIA. Therefore, the maps and area measurements referenced in other sections of the EIA may not align with those in this section.

The HLSA includes a large area of intact native prairie, one previously recorded archaeological site (EdPb-20), and a variety of previous ground disturbances (roads, canals, abandoned gravel quarries, dugouts, pipelines, and wells).

The HRSA was used in the assessment of historic resource potential for the EIA. The 1 km buffer was chosen to match what was used for the pre-field assessment in the HRIA report (Hill, 2022). The HRSA cannot be used as part of a cumulative effects assessment to address how Project

effects may interact with past, present, and future activities on regional resources or indicators. Cultural materials are affected by ground disturbance and exposure. A cultural landscape can be affected through scientific analysis of individual data points, or through destruction of scientific data. Evaluating the significance of Project activities across cultural landscapes is beyond the scope of this baseline and EIA.

14.3 ISSUE SCOPING

Scoping for this EIA is a process that includes:

- identifying the Project activities that may alter or remove the resources or indicators;
- developing a list of resources or indicators for each discipline;
- identifying the risks, issues, or concerns regarding these effects;
- determining what assessments to include (ones where high effects are likely), and which to exclude (effects are likely to be negligible or trivial); and
- the types of data/information available for the assessment will also help determine if the issue can be assessed locally and/or regionally.

Issue scoping for historic resources with the potential to be affected by the Project have been summarized (Table 14-2). The Project FTOR also identifies the need to describe previous historic resource studies or HRIAs within or near the Project area and to summarize any known historic resource sites within the Project area. In addition, a summary of historic resource sites reported from within the area has been included as part of this baseline.

Table 14-2: Issue scoping for historic resources

Project Activities and Risks	Resources	Indicators or Measures	Potential Issues	Screening
• Clearing of topsoil in the new reservoir area • Compaction of soils surrounding the development • Inhumation of surface under dam. • Inundation and sedimentation of surface under new waterbody. • Borrowing of gravel deposits within the Project footprint	• Archaeological deposits	• Surface/ subsurface archaeological features • Surface/ subsurface archaeological deposits	• Loss of scientific information through removal or displacement	• Likely – large areas of topsoil will be stripped
			• Confounding of scientific information through inhumation or inundation	• Likely – large areas will be buried and/or flooded
	• Quaternary palaeontological deposits	• Surface fossils from erosional context • Subsurface fossil-bearing gravel deposits	• Loss of scientific information through removal or displacement	• Likely – clay till deposits will be excavated for dam construction
			• Confounding of scientific information through inhumation or inundation	• Likely – large areas will be buried and/or flooded

Project Activities and Risks	Resources	Indicators or Measures	Potential Issues	Screening
• Borrowing of bedrock within the Project footprint	• Upper Cretaceous palaeontological deposits	• Surface fossils from erosional context • Subsurface fossil-bearing bedrock	• Loss of scientific information through removal or displacement	• Unlikely – while surface fossils are moderately common, there is enough borrow material overlying the bedrock that excavation of shale is not required for dam construction
			• Confounding of scientific information through inhumation or inundation	• Likely – large areas will be buried and/or flooded

14.4 ARCHAEOLOGICAL BASELINE

14.4.1 Historic Review

A search for known historic resources and information on these resources within the Project area was obtained from the Historic Resources Management Branch (HRMB) of ACSW. Topographic, satellite and elevation data were reviewed to qualify indicators where high potential for historic resource presence within the development areas but not limited to sites:

- within 1 km of permanent rivers or streams;
- within 1 km of well-formed valleys;
- within 1 km of permanent or seasonal waterbodies;
- within 1 km of smaller waterbodies situated in well-defined drainage basins;
- within 1 km of ancient lake strandlines or oxbows; and
- along prominent topographic features such as hills, escarpments, or ridges.

These environmental features have been associated with the location(s) of historic resources identified in the past. These locations can correlate strongly to various kinds of human activity patterns and supported by the distribution of archaeological sites found previously.

The HRIA was completed for the proposed development to identify and evaluate any historic resources that may be affected. The Project followed the principles outlined in *Section 37(2) of the Alberta Historical Resources Act* (GOA, 2000), the Guidelines for Archaeological Permit Holders in Alberta (Archaeological Survey of Alberta, 1989), and the *Archaeological and Palaeontological Research Permit Regulations* (GOA, 2002). The following objectives formed the basis of this study:

- Identification of previously recorded historic resource sites surrounding the proposed development.
- Identification and recording of any new historic resource sites that may be impacted by the proposed development.
- Evaluation of the significance and potential impacts to historic resource sites that could result from the proposed development.
- Recommendation of appropriate mitigative strategies, if necessary.

These objectives were achieved in two components: pre-field research and field survey.

14.4.2 Background Resources and Indicators

The proposed Project is located within Borden Block EdPb which extends from 50° 30´ to 50° 40´ latitude and 112° 10´ to 112° 20´ longitudes. Borden Block EdPb contains Snake Lake Reservoir in the north, as well as numerous small drainages and waterbodies. The block contains a combination of irrigated and non-irrigated cultivation, as well as native and non-native grazing land.

Historic resource sites are named based on the Borden Block in which they were discovered, followed by a sequential number based on the day the site reservation form was submitted to ACSW (i.e. EdPb-1, EdPb-2, etc.). A search of historic resources found previously in Borden Block EdPb was completed on July 26, 2021. The search revealed 23 archaeological sites. These were comprised of 4 campsites, 3 isolated finds, 10 artifact scatters, and 6 stone feature sites.

The Spring 2021 Listing of Historic Resources (GOA, 2021) held no Historic Resource Values (HRV) for the lands within the HRSA. Within the HLSA, one legal subdivision (LSD) had a value of 4 for archaeology, and five additional LSDs had a value of 5 for archaeology (Figure L1-1). According to the Listing of Historic Resources, HRVs relate to individual historic resource sites or lands, and are defined as follows:

- HRV 1: contains a World Heritage site or a site designated under the HRA as a Provincial Historic Resource;
- HRV 2: deactivated (formerly used to designate a Registered Historic Resource);
- HRV 3: contains a significant historic resource that will likely require avoidance;
- HRV 4: contains a historic resource that may require avoidance or assessment; and
- HRV 5: high potential to contain a historic resource.

Additionally, HRV 0 is a site-specific value that relates to a resource that is not significant enough to warrant avoidance or mitigation. Sites with an HRV greater than zero will lend that value to the LSD on which the site is located. LSDs surrounding an LSD with a known resource will generally receive an HRV of 5. These values are somewhat arbitrary but are used as a screening tool for certain types of activities. For reservoir projects, the HRV of the affected lands is not relevant to the regulatory process. Historic resource potential for large projects is defined by a broader list of criteria.

The HRSA contained four previously recorded archaeological resource sites; EdPb-16, EdPb-17, EdPb-18, and EdPb-20. EdPb-16 is an HRV-4 stone feature site located on the north edge of the Snake Lake coulee. EdPb-17 is an HRV 0 artifact with scattered materials located on the eroded slope of the Snake Lake coulee prior to flooding of the reservoir. EdPb-18 is an HRV 0 artifact scatter located on an erosional feature within rolling native prairie. EdPb-20 is an HRV 0 artifact scatter located on rolling native prairie. EdPb-20 is the only site within the HLSA.

Archaeological resource site locations are considered sensitive information and are protected under provisions of the Alberta *Historical Resources Act* (GOA, 2000). This information can only be used internally by project planners and historic resource professionals. Dissemination of locational information in public-facing documents is restricted. As such, we have not included a map of all known historic resource sites in the Project area in this publicly-available document.

Copies of documents containing this information can be acquired through written request to the HRMB.

The HRSA and HLSA were subjects of two previous HRIAs. Permit 92-085, the original Snake Lake Reservoir Project, was completed to the west of the proposed Project, as well as in the north portion of the proposed Project (Dau, 1992). This resulted in the discovery of EdPb-16, EdPb-17, and EdPb-18. Permit 98-127 comprised a network of shallow gas pipelines spread throughout the LSA (Hanna, 1998). This resulted in the discovery of EdPb-20, an HRV-0 artifact scatter site.

14.4.3 Archaeological Survey Methods

Following referral of this Project by the EID, a Historic Resources Application was made to ACSW. A signed requirement letter was issued (Historic Resources Management Branch File No. 4825-21-0010-001) which called for an HRIA for all areas of high archaeological potential. An Archaeological Research Permit Application was made to ACSW and Permit No. 2021-073 was issued June 10, 2021. Fieldwork was completed between June 14 and June 30, 2021, using standard survey techniques involving pedestrian traverses, visual inspection of the ground surface and subsurface (hand shovel and mechanical excavator) testing of the proposed development area. Whenever possible, opportunistic soil exposures, such as excavations as part of the dam design and geophysical testing programs, were inspected. The HRIA was completed under snow-free and frost-free conditions.

564 shovel tests, 5 mechanical deep tests, and 908 subsurface exposures were inspected within the local study area to assess the potential for buried historic resources. Deep testing was performed as a joint-effort between the archaeological and palaeontological crews. OneCalls were placed on July 29, 2021, and each excavation location was swept for buried facilities by qualified locators provided by the contractor performing the excavation work. Shovel testing was limited to the depth of surficial sediments (<30 cm below surface) and did not require OneCalls or locates.

14.5 PALAEONTOLOGICAL BASELINE

14.5.1 Historic Review

The area of the proposed development (Appendix L1, Figure L1-2) was reviewed for quaternary geology and potential for palaeontological resources. Application for a Mitigative Palaeontological Permit (Permit to Excavate Palaeontological Resources) was submitted to the RTMP and a signed permit (Permit No.: 21-066) was received for the Project as per the *Historical Resources Act* and *Archeological and Palaeontological Research Permit Regulation* (GOA, 2000; 2022) Pre-field research included a geology review and assessment of palaeontological potential of the Project area. This information included high potential sites for assessment and was used to select field survey routes.

The Listing of Historic Resources was reviewed for the planned Project site. Each parcel of land is assigned a Historic Resources Value (HRV) from 1 to 5. For example, HRV 4 land "contains a historic resource that may require avoidance," while HRV 5 land is "believed to contain a historic resource." The letter 'p' will be included in a listing if the primary historic resource category of concern is palaeontology. "5p" lands are considered "High Palaeontological Resource Sensitivity Zone" lands, and "4p" lands contain fossil resources that are (or will be) assigned a site name.

The listing did not include any previously listed lands with palaeontological resources in the Project area. However, the size and depth of excavations of the proposed Project suggests areas of the Project footprint could have high palaeontological potential.

A literature search and review of publications, theses, and other research reports on the geology and palaeontological resources of the development area occurred prior to site visits occurred. Known and/or documented palaeontological sites in the Project area from available data (e.g. recovered specimens, geotechnical reports, or locally sourced observations were used to assess areas of high palaeontological potential within the known Quaternary ('Ice Age') and pre-Quaternary (Late Cretaceous) Bearpaw Formation deposits (Appendix L1, Figure L1-2); areas and strata with high palaeontological potential within the Project area were also assessed.

Surface features and possible outcrops/exposures in and around the proposed development were assessed initially using aerial photography and/or satellite imagery, surface elevations and enhanced hill-shade surface views based on light detection and ranging (LiDAR) information, geographic information system (GIS) maps, construction/survey plans and sketches, geotechnical reports, and topographic/contour maps scaled from 1:2,000,000 to 1:2,000. This information, in conjunction with the pre-field research, provided a working overview of the development site to help target known fossiliferous sites and areas of high palaeontological potential within the Project footprint where fossil-bearing sediments are likely to be affected.

14.5.2 Background Resources and Indicators

The surficial sediments in the development area are comprised of fluvial silt, sand, and gravel (fluvial, glaciolacustrine, and stagnant ice moraine) deposits. Sand and gravel deposits within the central and southwestern areas of the Project footprint have high potential to contain significant Quaternary resources. A palaeovalley immediately northeast of the Project footprint suggests *in situ* and reworked pre-glacial and interglacial gravels may be present within the Project footprint.

The Project footprint is completely underlain by the Cretaceous (Campanian-Maastrichtian, approximately 70-76 million years) Bearpaw Formation (Appendix L1, Figure L1-2). The Bearpaw Formation is primarily shale that was originally deposited as mud on the seafloor of the Western Interior Seaway that stretched from the Gulf of Mexico through the western U.S. into the prairie provinces of Canada. This formation consists of marine to marginal marine deposits comprised of dark-grey, blocky shale, silty shale, greenish (glauconitic) and grey, clayey sandstone, and thin concretionary sideritic and bentonite layers; the formation is known to locally yield ammonites (Prior, et al., 2013).

Bedrock exposures of the Bearpaw Formation within the Project footprint were noted in satellite images during the background review. Outcrops of this formation are visible along the Red Deer River, Bow River, and creek systems near the Project. Significant fossil resources have been recovered from the Bearpaw Formation in this region of Alberta, suggesting local bedrock units have high palaeontological potential. Significant vertebrate (marine reptiles [mosasaurs, plesiosaurs, turtles] and fish) and invertebrate (ammonites, mollusks, and cephalopods) fossil remains have also been recovered from outcrops and exposed bedrock of the Bearpaw Formation along the major and minor rivers systems throughout this region. 'Pre-glacial' (Empress Formation) and Quaternary post-glacial gravel deposits across this region of the province are known to contain significant 'ice-age' mammal remains and are also of interest for this study.

Sand and gravel deposits of the Empress Formation (formerly known as 'Saskatchewan Gravels') from the Late Wisconsinan - Pleistocene interglacial period are known to contain significant Pleistocene vertebrate remains and may be present within the Project footprint.

14.5.3 Palaeontological Survey Methods

A field survey of the Project area was completed on August 13, 18, and 21, and September 9, 2021. The on-site survey was completed using pedestrian and vehicular reconnaissance of the Project lands. A pre-planned route was taken to ensure that all potential areas where fossil remains and/or fossiliferous sediments might be impacted (e.g. earth bank borrow sources, canals, outfall structures, access roads, deep utilities) and areas to be submerged within the new reservoir were surveyed. The survey searched for any Quaternary fossil resources within the sand and gravel deposits and outcrops of the Bearpaw Formation within the Project footprint.

The two-person field crew searched for and examined all exposed bedrock layers along the existing Snake Lake Canal and local drainages for eroded or reworked fossil resources (both Pre-Quaternary and Quaternary) and to determine the potential for construction activities to impact fossil resources and/or fossiliferous bedrock. Archaeology deep test pits (n = 5) were also monitored for Quaternary and Pre-Quaternary resources.

14.6 HISTORIC IMPACT ASSESSMENT

Impact assessment on historic resources differs from the EIA methods for most disciplines, as it is governed by the processes and requirements of ACSW and the *Historical Resources Act* (GOA, 2000). To assess the potential impacts of the Project on historic resources, the results from the Historic Surveys (Archaeological and Palaeontological) were described and assessed. The nature and magnitude of these effects were also assessed. Once the above criteria and considerations were rated, the residual impact rating was assessed for each resource or indicator. The residual impact rating was assessed as Low, Moderate, or High.

14.6.1 Archaeological Survey Results and Historic Resources Impact Assessment

Of the tests conducted, 12 shovel tests were positive for cultural material, as were 47 exposures. This resulted in the discovery of 22 new archaeological sites. One previously recorded archaeological site, EdPb-20, was revisited during this HRIA.

As a result of this HRIA (Permit No. 2021-073):

- EdPb-20 was a previously recorded prehistoric surface scatter with less than 10 artifacts discovered under permit 98-127. This site will be included within the flooded portion of the proposed reservoir expansion. Based on the eroded and scientifically limited nature of this site, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of this site. Maintaining the HRV of 0 was recommended.
- EdPb-24, EdPb-25, EdPb-26, EdPb-27, EdPb-29, EdPb-30, EdPb-32, EdPb-33, EdPb-34, EdPb-38, EdPb-40, and EdPb-41 were newly recorded prehistoric surface scatters with less than 10 artifacts. These sites will be included within the flooded portion of the proposed reservoir expansion. Based on the eroded and scientifically limited nature of

these sites, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of these sites. An HRV of 0 was recommended.

- EdPb-28 was a newly recorded stone feature site consisting of a well-defined cairn and associated surface scatter (Plate 14-1). This site will be partially or totally inhumed by the dam construction. Due to the presence of a large cairn and associated lithic artifacts at this location, EdPb-28 was considered to have high scientific value. An HRV of 4 was recommended. EdPb-28 will experience a loss of site integrity and cultural information because of the proposed development. Before berm construction occurs, it was recommended that the cairn be mapped and a 2 m x 2 m excavation be used to fully excavate the stone feature. Refer to section 14.7.1 for impact mitigation that was completed.

Plate 14-1: Cairn located at EdPb-28

- EdPb-31 and EdPb-44 were newly recorded prehistoric isolated find sites. These sites will be totally inhumed by the dam construction (i.e., buried under the berms of the expanded reservoir)**.** Based on the eroded and scientifically limited nature of these sites, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of these sites. An HRV of 0 was recommended.
- EdPb-42, EdPb-43 and EdPb-45 were newly recorded prehistoric isolated find sites. These sites will be included within the flooded portion of the proposed reservoir expansion**.** Based on the eroded and scientifically limited nature of these sites, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of these sites. An HRV of 0 was recommended.
- EdPb-35 was a newly recorded prehistoric surface scatter and quarry site with more than 10 artifacts. This site will be included within the flooded portion of the proposed reservoir expansion**.** Based on the eroded and scientifically limited nature of this site, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of this site. An HRV of 0 was recommended.
- EdPb-36 was a newly recorded prehistoric surface scatter and quarry site with more than 10 artifacts. This site will be included within the flooded portion of the proposed reservoir

expansion. Based on the eroded and scientifically limited nature of this site, no further work was recommended. Artifact collection and observation has provided a sufficient record of the nature of this site. An HRV of 0 was recommended.

- EdPb-37 was a newly recorded prehistoric buried FBR scatter with more than 10 artifacts. The FBR scatter was collected from 8 positive shovel tests. This site will be included within the flooded portion of the proposed reservoir expansion. Given the high yield of buried FBR in the site area, the site was considered to hold moderate scientific value, on the condition that archaeological features or other artifact types could be discovered through more intensive excavation. An HRV 4 designation was recommended for EdPb-37. ACSW argued that a site consisting only of FBR did not provide sufficient scientific value to warrant mitigative excavation, and that the sample gathered by the HRIA was sufficient. An HRV of 0 was assigned to this site.
- EdPb-39 was a newly recorded prehistoric campsite consisting of four cairns and five stone circles (Plate 14-2). The site also included buried artifacts recovered from four positive shovel tests. EdPb-39 will be included within the flooded portion of the proposed reservoir expansion. Due to the presence of multiple stone features as well as buried cultural material, EdPb-39 was considered to have high scientific value. An HRV of 4 was recommended. Before reservoir expansion work occurs, it was recommended that each cairn be mapped and bisected with a 1 m x 2 m excavation, while each stone circle be mapped and excavated with a 1 m x 2 m excavation. An additional 20 m of excavation should be distributed across the site, localized to the exterior of the stone features and positive shovel tests. Refer to section 14.7.1 for impact mitigation that was completed.

Plate 14-2: Stone circle at EdPb-39

Submission and Consultation with ACSW

The HRIA was completed on June 30, 2021. The results of the HRIA were submitted to ACSW as a Final Report, which included avoidance and mitigation recommendations for those archaeological sites with significant scientific potential. After review of the HRIA Final Report (Permit No. 2021-073), ACSW produced stage-one mitigative excavation requirements for EdPb-28 and EdPb-39 in May, 2022.

Recommendation for no further work associated with HRV 0 sites was also accepted by ACSW. Consequently, reservoir expansion would be allowed to proceed around those sites. The sites with no further work required based on the HRIA recommendations were EdPb-20 through 27, 29 through 38, and 40 through 45.

14.6.2 Palaeontological Survey Results and Historic Resources Impact Assessment

The Bearpaw Formation shale within the Project footprint was examined in a series of test pits along with several small, isolated outcrops and an 8 m thick, approximately 400 m long exposure on the north side of the Snake Lake Canal. The east-west canal cuts through the hummocky landscape and exposes Bearpaw shale at shallow depths beneath the surface. The shale is sloped and partially overgrown with prairie grass. The south side of the canal bore only patchy exposures of Bearpaw shale.

The shale is sub-horizontally bedded with a slight dip (tilt) to the west. Bedding is presumed originally horizontal with the westward dip occurring after the shale was buried, in post-Cretaceous time, during episodes of Cenozoic mountain-building and orogenic adjustment. The shale is generally medium grey but individual beds vary in tint from green- to brown-grey.

Siderite (iron carbonate) concretions, or nodules, occur along a few discrete, laterally-continuous horizons (layers) in the 400 m long exposure. Because the Bearpaw shale is sloped and weathered, concretions lie scattered like gravel along the slope of outcrops. Most fossils, primarily ammonites and bivalves, occur in concretions. Other fossils, mainly fish material, are rare in the shale.

Because horizons with nodular concretions are continuous throughout the outcrop, they are presumably contiguous in the subsurface of the Project footprint. Care should be taken during excavations that expose Bearpaw shale to watch for the presence of fossiliferous concretions. The palaeontological resources (fossils, trace fossils, etc.) that were discovered during the Field Survey were documented by GPS location (WGS 84) and photographed. Significant specimens were collected and catalogued. These will be deposited at the RTMP in Midland Provincial Park, Alberta.

Upon completing the field survey within the Project footprint, 18 new fossil sites and 2 outcrops were documented. Significant fossil resources were recovered from 12 of the 18 fossil sites. The newly documented fossil sites are summarized below.

Snake Lake Site 1

Site Description: Fossil collected *ex-situ* along north canal road, likely weathered out of nearby outcrop of Bearpaw Formation. Fossil embedded in mudstone matrix.

Specimen Description: Fossil ammonite (*Baculitidae indet.*) shell fragment (Plate 14-3).

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-3: Internal view of *Baculitidae indet.* at Site 1

Snake Lake Site 2

Site Description: Fossils collected along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Ammonites (*Placenticeras intercalare*, *Placenticeras meeki*, Scaphitidae indet.) shell and body cavity fragments, fossil wood fragment. Fossils documented and collected (Plate 14-4).

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-4: Fossil shell fragment of the ammonite *Placenticeras meeki* from Site 2

Snake Lake Site 3

Site Description: Fossils observed along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: *Osteichthyes* indet. (boney fish) vertebra, ammonite (Baculitidae indet.). Weathered fish vertebra recovered but disintegrated post-collection (Plate 14-5); ammonite documented but not collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-5: *Osteichthyes* indet. vertebra from Site 3

Snake Lake Site 4

Site Description: Fossil collected ex-situ on weathered mudstone bedrock of the Bearpaw Formation, adjacent to a small pond north of north canal road.

Specimen Description: Ammonite (*Placenticeras meeki*) shell fragment (Plate 14-6). Fossil documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-6: Fossil shell fragment of the ammonite *Placenteras meeki* at Site 4

Snake Lake Site 5

Site Description: Fossils observed along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Ammonite (unidentified) shell and bivalve (unidentified, not collected) shell (Plate 14-7). Fossils documented and the ammonite collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-7: Fossil ammonite shell fragments at Site 5

Snake Lake Site 6

Site Description: Fossil observed along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Ammonite (unidentified) shell fragment (Plate 14-8). Fossil documented but not collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-8: Fossil shell of unidentified ammonite at Site 6

Snake Lake Site 7

Site Description: Fossils observed along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Shark (*Squalicorax* cf. *S. kaupi*, Todd Cook, Penn State Behrend, pers. comm. to Aeon Paleontological Consulting Ltd., 2021) tooth and ammonite (unidentified, not collected). Fossils documented and the shark tooth collected (Plate 14-9).

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-9: Fossil shark (*Squalicorax cf S. kaupi*) tooth at Site 7

Snake Lake Site 8

Site Description: Fossil collected along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Ammonite (*Placenticeras intercalare*) shell fragment (Plate 14-10). Fossil documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-10: Fossil ammonite shell fragments at Site 8

Snake Lake Site 9

Site Description: Fossils collected along north canal road cut, consisting of weathered mudstone bedrock of the Bearpaw Formation.

Specimen Description: Ammonite (*Placenticeras* sp.) shell fragments (Plate 14-11).

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-11: Fossil ammonite shell fragments at Site 9

Snake Lake Site 10

Site Description: Bones found in grass at prairie level.

Specimen Description: Recent coyote (*Canis latrans*) dentaries (Plate 14-12). Bones documented but not collected.

Formation: Surficial sediment deposit.

Plate 14-12: Recent coyote (*Canis latrans*) dentaries at Site 10

Snake Lake Site 11

Site Description: Bones found in grass at prairie level.

Specimen description: Recent porcupine (*Erethizon dorsatum*) left dentary (Plate 14-13). Bone documented but not collected.

Formation: Surficial sediment deposit.

Plate 14-13: Recent porcupine (*Erethizon dorsatum*) left dentary at Site 11

Snake Lake Site 12 (Test Pit 1)

Site Description: Fossils collected from backfill pile from excavated test pit, consisting of mudstone bedrock of the Bearpaw Formation. Ammonite fossils derived from a horizon approximately 1.5 m below surface.

Specimen description: Ammonite (*Placenticeras intercalare*, *Placenticeras* sp., Scaphitidae indet., Ammonitida indet.) shell fragments, bryozoan (*Membranipora* sp., Cheilostomatida indet.) colonies, feeding or burrowing trace fossils (Plate 14-14). Fossils documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-14: Ammonite fossils derived from the mudstone bedrock at Site 12

Snake Lake Site 13 (Test Pit 3)

Site Description: Fossils collected from backfill pile from excavated test pit, consisting of sandy siltstone to dark grey mudstone bedrock of the Bearpaw Formation.

Specimen description: Unidentified fossil leaf fragment and possible feeding or burrowing trace fossils (Plate 14-15). Fossils documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-15: Unidentified fossil leaf fragment at Site 13

Snake Lake Site 14 (Test Pit 4)

Site Description: Fossils found in backfill pile from excavated test pit, consisting of siltstone to silty sandstone bedrock of the Bearpaw Formation.

Specimen description: Fossil plant debris and feeding or burrowing trace fossil. (Plate 14-16). Fossils documented but not collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-16: Coalified plant debris at Site 14

Snake Lake Site 15

Site Description: Fossils collected ex-situ, likely weathered out of the underlying Bearpaw Formation.

Specimen description: Unidentified fossil clam shell fragments (Plate 14-17). Fossils documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-17: Ex-situ unidentified fossil clam shell fragment at Site 15

Snake Lake Site 16

Site Description: Bones found in grass at prairie level.

Specimen description: Recent cow (*Bos taurus*) skull and atlas (Plate 14-18). Bones documented but not collected.

Formation: Surficial sediment deposit.

Plate 14-18: Recent cow (*Bos taurus*) at Site 16

Snake Lake Site 17

Site Description: Fossil collected ex-situ, likely weathered out of underlying Bearpaw Formation.

Specimen description: Unidentified fossil clam shell fragment (Plate 14-19). Fossil documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-19: Unidentified fossil clam shell fragment at Site 17

Snake Lake Site 18

Site Description: Fossil collected ex-situ, likely weathered out of underlying Bearpaw Formation.

Specimen description: Unidentified fossil wood fragment (Plate 14-20). Fossil documented and collected.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Plate 14-20: Fossil wood fragment at Site 18

BR1 (Test Pit 2)

Site Description: Dark grey mudstone bedrock of the Bearpaw Formation, excavated from test pit. 'BR' stands for bedrock. No fossils observed.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

BR2 (Test Pit 5)

Site Description: Wet sandy clay to dark grey clay, either saturated Bearpaw Formation bedrock or clay till, excavated from test pit. No fossils observed.

Formation: The surrounding area is mapped as the Upper Campanian Bearpaw Formation.

Summary of Fossil Resources

As typical for the Bearpaw Formation shale, almost all fossils were discovered in concretions. Concretions were recovered in fragments, so no single, whole fossil survived. All fossils were partial.

Ammonites

Coiled ammonites were overwhelmingly the most abundant fossil recovered. Most were unidentifiable fragments of shell material preserved as original aragonite and lightly altered to ammolite in shades of pink and maroon.

Placenticeras spp. were 45% of all ammonites recovered. Two species are reported from outcrops along the Bow River near Snake Lake: *P. meeki* and *P. intercalare* (Tsujita & Westerman, 1998). Both species have distinctive shell exteriors and cross-sections which facilitate identification of partial shell material. *P. intercalare* bears two rows of tubercles (bumps), one each along the ventrolateral (outer) and umbiloclateral (inner) edge of the shell, which parallel the whorls as ammonites grew. *P. meeki* lacks tubercles, so its shell surface is smooth and unmarred by protruding ornament.

In cross-section, *P. meeki* is narrower than *P. intercalare* and bears a distinct keel (protrusion) along the ventral (outer) edge of the shell, a feature critical in many ammonite identifications. In recovered specimens, the presence or absence of the keel is important in *Placenticeras* identification, especially when exterior shell material that might bear tubercles is missing or for fragments of ammonites that are recognizable only in cross-section, because *P. intercalare* lacks a keel. *P. intercalare* specimens are also broader in cross-section than *P. meeki.* Notably, in juvenile specimens and the oldest whorls, the cross-section of *P. intercalare* is an elongated pentagon, compared to the ovate cross-section of *P. meeki.*

Nearly half of all *Placenticeras* specimens were identifiable to species. Of the 31 *Placenticeras* spp. specimens, 11 were *P. intercalare* and 4 were *P. meeki.* Most *P. intercalare* specimens were identified based on tubercles; *P. meeki* identifications were strongly dependent on the presence of the keel and the cross-section of the whorl. Unidentified specimens were usually small shell fragments that lacked diagnostic features.

Other identifiable ammonites were scaphitids (2 fragments) and a segment of straight-shelled *Baculites* sp. Although *Baculites* spp. from nearby Bearpaw shale outcrops are usually identifiable

based on the cross-section of the shell (Tsujita & Westerman, 1998), the recovered specimen was too partial to identify.

Three scaphitid species are known from nearby outcrops (Tsujita & Westerman, 1998); however, the recovered shell fragments from the Snake Lake reservoir expansion excavations were too partial for identification to genus level. Scaphitids, like *Placenticeras intercalare,* bear tubercles. Scaphitid tubercles are more abundant and robust than *P. intercalare,* which facilitated the identification of the two fragments. Among the unidentifiable ammonite fragments, four specimens bore tubercles that were indistinguishable between scaphitid and *P. intercalare.*

Other Invertebrates

The concretion fragments bore few other fossils. Three bivalves are present: two unidentified clams and a fragment of an inoceramid, an extinct Cretaceous-age bivalve that is related to mussels.

Two bryozoans (moss animals) are present, one of which is identified as an unknown species of *Membranipora.* Bryozoans are colonial animals, similar in colonial habit to corals, but they are more complex animals than corals and are nearly microscopic in size. Furthermore, bryozoan colonies must attach to a stable substrate and would not survive on the mud at the bottom of the Bearpaw sea. The bryozoan colonies found in the concretions were attached to unidentified ammonite shells. It is unknown whether the ammonite was alive and swimming through the sea when the bryozoan was attached or the shell of the dead ammonite lay inert on the sea floor and provided a stable location for encrustation by bryozoans.

Wood

Fragments of wood were also discovered in the concretions. These presumably were brought to the sea by rivers and eventually became waterlogged to lie on the sea floor. Wood is known to float across present-day oceans, so the presence of wood fragments in the concretions does not indicate proximity of the site to an ancient shoreline.

14.7 HISTORIC IMPACT MITIGATION

14.7.1 Archaeological Historic Resources Impact Mitigation

EdPb-28 was identified as a stone feature site consisting of a well-defined cairn and associated surface scatter under Permit 21-073. The site was located along the bed of a seasonal waterbody. Lithic artifacts recovered from the surface near the stone feature consisted of one chert flake and one piece of chert shatter.

EdPb-39 was identified as a prehistoric campsite consisting of four cairns and five stone circles. The site also included buried artifacts recovered from four positive shovel tests. Given the presence of multiple stone features as well as buried cultural material, EdPb-39 was considered to have high historic resource value. The site covered the entire upper portion of a long knoll located within a shallow paleochannel that extends east of the Snake Lake Reservoir dam.

An Archaeological Research Permit Application was made to ACSW and Permit No. 2022-065 was issued on June 7, 2022. The historic resources impact mitigation (HRIM) was initiated on

July 13, 2022, and terminated on September 9, 2022, after 5 weeks of mitigative testing and excavation.

The HRIM began with the grid shovel testing of EdPb-39, which resulted in 214 shovel tests excavated with 29 of those being positive for cultural material. In total, 18 m^2 were excavated in relation to the stone features at EdPb-39. Excavation was performed in 10 cm levels and within 50 cm x 50 cm quadrants to provide increased sampling control. Following mitigative excavations at each stone feature with eight additional units centred on positive shovel tests, no further excavation at EdPb-39 was recommended.

Excavation of EdPb-28 was limited to 2 m^2 bisecting the cairn feature. This excavation resulted in the discovery of three pieces of cultural material. Based on these results, no further excavation of this feature was necessary.

Artifacts collected during the mitigative excavation of EdPb-28 and EdPb-39 were catalogued and analyzed. Artifacts are typically stored with the consultant until final approval is received. The artifacts are then transferred to the Royal Alberta Museum for permanent storage.

All artifact analyses, and the planned Project footprint, were submitted to ACSW in a Final Report on June 1, 2023. Historical Resources Act Approval with Conditions was granted by ACSW on January 24, 2025. Additional temporary workspace and storage locations will require a Historic Resources Amendment. The application for this amendment was submitted April 15, 2024, covering additional areas shown in Figure L1-3.

All pre-construction mitigations have been completed. No others are recommended with respect to archaeological resources. Thus, primary cultural information has been salvaged through mitigation and there are only minor losses of cultural information. When construction occurs, standard requirements under Section 31 of the *Historical Resources Act* will apply. These state that the any new or accidental discoveries of historic resources must be reported to ACSW and contact information for individuals within the HRMB and the RTMP are provided. Accidental discovery of a significant cultural resource may require further salvage, preservation or protection. The mitigation measures required would be at the discretion of the Minister of ACSW.

As archaeological HRIM has been completed to the satisfaction of the Ministry of ACSW, with the caveat than any significant discoveries will be addressed during construction, all effects on archaeological resources are considered low and short term in duration (i.e., the effects on any new discoveries will be mitigated in less than 5 years, during construction).

14.7.2 Palaeontological Historic Resources Impact Mitigation

A strip of land ranging from approximately 8.7 to 211 m wide, surrounding the Project footprint, will be stripped and excavated to provide a stable sediment base for the proposed earthen dam. After assessing geology and contour maps, MPE's test pit logs and images, Project development plans and analyzing field survey observations, it was determined that excavation activities will affect sand and gravel deposits along the eastern side of this proposed dam, as well as portions of the northern side of the dam. Deep grade-cutting activities for the dam footprint also have the potential to affect the underlying Bearpaw Formation shale within this area. Given sand and gravel deposits in this area of the province have a high potential

to yield significant Quaternary fossil resources (i.e., extinct 'Ice Age' mammals), a monitoring program is recommended during all grade cut and excavation activities for this area of the Project. The underlying fossil-rich, marine Bearpaw Formation shale will also need to be monitored.

In addition, if some of the proposed borrow-source clay-till is determined unsuitable for dam construction and if additional borrow material (weathered Bearpaw Formation shale) is required to complete the construction of the earthen dam, the shale will likely be excavated from the central area of 'Borrow Source A2'. These excavations into weathered shale will be up to 3 m deep. A monitoring program is recommended for 'Borrow Area A2' (and any other borrow source areas) that will affect weathered (oxidized) and unweathered Bearpaw Formation shale.

The EID is advised that should equipment operators discover palaeontological resources exposed in place and/or in a waste (spoil) pile during any excavation, then excavation at the discovery site must stop and the consulting palaeontologist, or staff of the RTMP, must be contacted before proceeding. According to Section 31 of the *Historical Resources Act*, "a person who discovers a historic resource in the course of making an excavation for a purpose other than for the purpose of seeking historic resources shall forthwith notify the Minister of the discovery" (GOA, 2000).

This assessment identified presence of primary faunal remains; however, any discoveries will be effectively salvaged through planned monitoring and self-reporting to the Ministry of ACSW. As palaeontological HRIM will be completed during Project activities, by monitoring and addressing any significant fossil finds, if any, effects on palaeontological resources are considered as low in magnitude and short-term in duration (i.e., these impacts will be addressed in less than 5 years, during construction).

14.7.3 Residual Impacts

As demonstrated in Table 14-3, most Project activities have the potential to impact historic resources, as discussed in section 14.7.1 and 14.7.2.

Table 14-3: Project activities and potential impacts on historic resources

Project Stage	Specific Activity	Focus of Assessment		
		Loss or Confounding of Surface/Subsurface Archaeological Resources	Loss or Confounding of Surface and Subsurface (Quaternary) fossil bearing deposits	Loss or Confounding of Bedrock fossil bearing deposits
Clearing and Construction	Clearing	✓	✓	-
	Dam and berm construction	✓	✓	✓
	Road construction	✓	✓	✓
	Lay down areas and temporary workspaces	✓	-	-
	Soil Storage Area	✓	-	-
	Reclamation	-	-	-
Operations	Reservoir Inundation	✓	✓	✓

Note: ✓= potential interaction, - = no interaction

Tables 14-4 (below) is an overview of the impact assessment on archaeological and palaeontological historic resources as a result of Project activities. The residual impact is determined from Project effects after applying mitigation measures.

Table 14-4: Project effects on historic resources impact assessment and residual impacts

#	Impact Description	Direction	Key Criteria			Modifiers		Residual Impact Rating
			Magnitude	Geographical Extent	Duration	Confidence	Ecological and Social Context	
Construction and Filling								
1	Loss of scientific information through removal or displacement of archaeological deposits	Negative	Low	Footprint	Short-Term	Medium	N/A	Low Negative
2	Confounding of scientific information through inhumation or inundation of archaeological deposits	Neutral						Neutral
3	Loss of scientific information through removal or displacement of Quaternary palaeontological deposits	Negative	Low	Footprint	Short-term	Medium	N/A	Low Negative
4	Confounding of scientific information through inhumation or inundation of Quaternary palaeontological deposits	Negative	Low	Footprint	Short-term	Medium	N/A	Low Negative
5	Loss of scientific information through removal or displacement of Upper Cretaceous palaeontological deposits	Negative	Low	Footprint	Short-term	Medium	N/A	Low Negative
6	Confounding of scientific information through inhumation or inundation of Upper Cretaceous palaeontological deposits	Negative	Low	Footprint	Short-term	Medium	N/A	Low Negative
Operation								
No resources were assessed at this stage.								

Negative impacts to archaeological resources are considered by the HRMB to be long-term and of a high magnitude as the default position. Archaeological resources tend to occur within upper sediment strata, making them particularly sensitive to surface traffic and shallow ground disturbance activities.

Archaeological resources are categorized as HRV 0 if the archaeological site is of a relatively low cultural significance or scientific interest. If they are of moderate or high cultural significance or scientific interest, then they are given an HRV of 4. HRV 4 resources require avoidance or mitigative study prior to construction. Displacement of cultural material can destroy scientific information about the site or have other negative cultural effects. HRV 4 sites that are located within the Project footprint are considered to be under the long-term custody of the developer and must be mitigated to reduce potential loss of information before custody is granted for those lands. Once mitigation efforts have been performed to the satisfaction of ACSW reviewers, the HRV is reduced to 0 at those sites. The residual impacts would then be considered long-term and low.

Similarly, palaeontological resources would face long-term and high magnitude negative impacts. Mitigation for palaeontological resources often takes the form of systematic monitoring programs and self-reporting of fossil discoveries. These are performed during construction. These efforts rely on ground disturbance operations to expose and identify fossil resources and are designed to reduce the magnitude of the impact through salvage measures. With a monitoring program in place, the magnitude of negative impacts can be reduced to low.

14.8 CUMULATIVE EFFECTS ASSESSMENT

Cumulative effects were not assessed as mitigation efforts are expected to result in low residual effects.

14.9 MONITORING

As per the HRA Approval with Conditions (HRA Number: 4825-21-0010-003), a monitoring program is required for excavation activities and grade cuts along the eastern and northeastern areas of the proposed Project footprint, as Quaternary and bedrock deposits have a high potential to yield significant palaeontological resources in this area.

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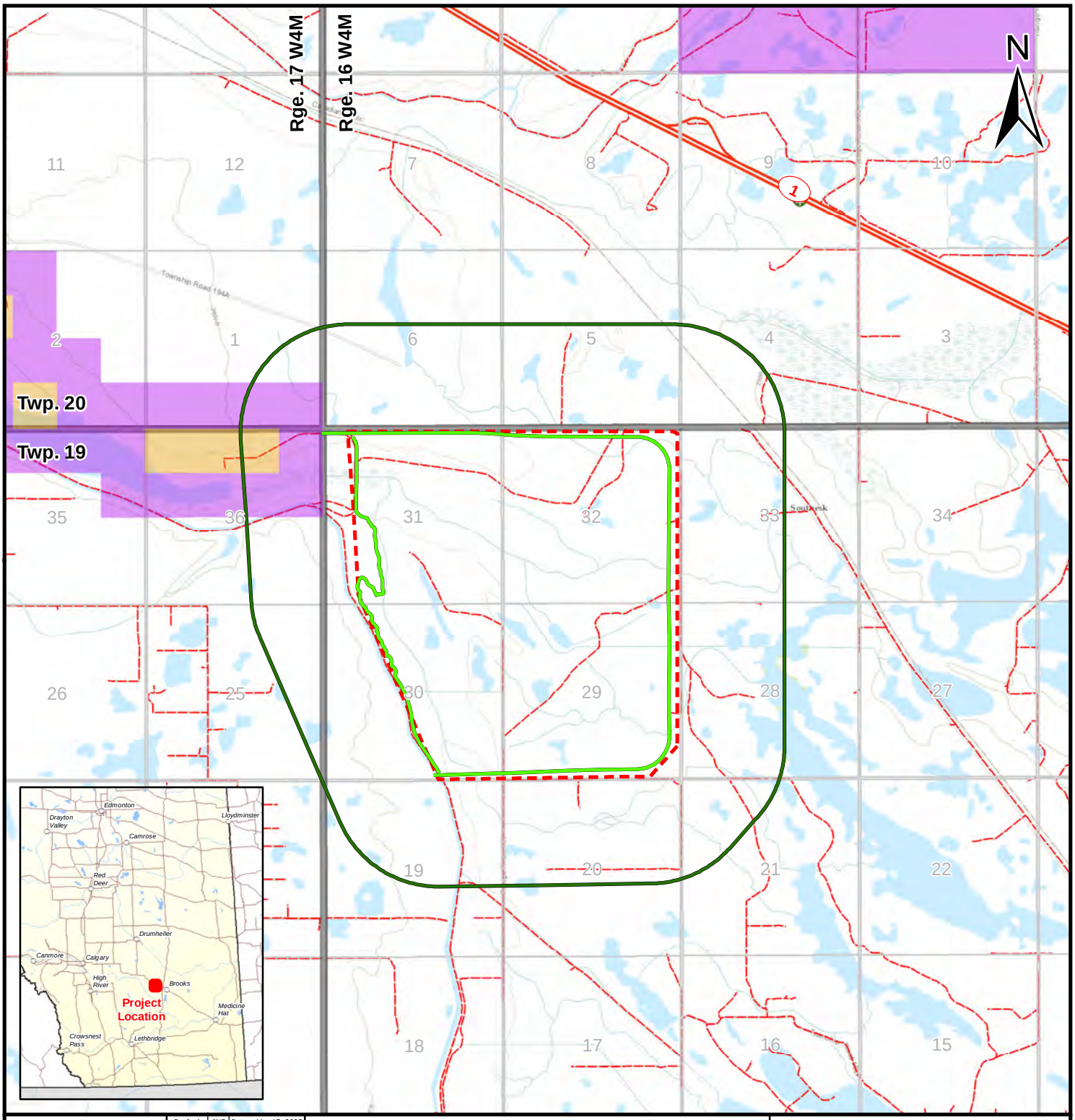
Appendix L

Appendices

Figures

Appendix L1: Figures



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Approved:	DH	Revision:	0
Route Source:		Date:	Feb 18, 2022
CAD Survey		Revision:	0

Data Sources:
ESRI World Topographic Map
ATS Grid: AltaLIS 2007.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the topographic map is from 2010 (NRCAN) and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Historic Resources Regional Study Area
- Historic Resources Local Study Area
- Initial HRIA Survey Area
- Lands with Historical Resource Value 4 for Archaeology (2021 version)
- Lands with Historical Resource Value 5 for Archaeology (2021 version)
- Unpaved Road
- Paved Road
- Canal/Watercourse

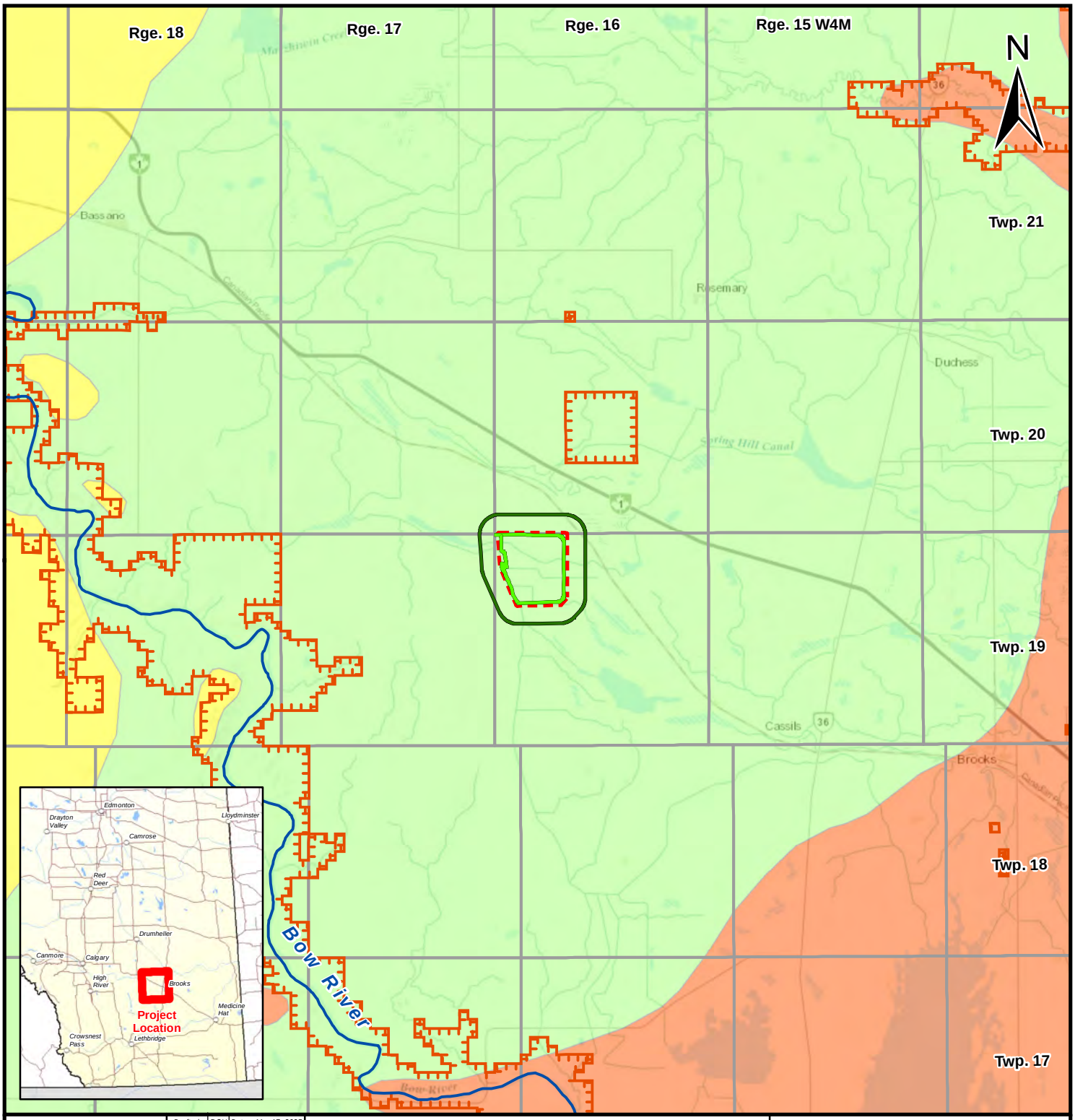
EID

Historic Resources Local and Regional Study Areas

March 2025

REF.: AARES21-127 (Historical Resources)

Figure L1-1



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Approved:	WB	Revision:	0
Route Source:		Date:	Feb 18, 2022
CAD Survey		Revision:	0

Data Sources:
ESRI World Topographic Map
ATS Grid: AltaLIS 2007.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the topographic map is from 2010 (NRCAN) and although we have no reason to doubt the accuracy and completeness of it, users should be aware discrepancies may be present.

Legend

- Historic Resources Regional Study Area
- Historic Resources Local Study Area
- Lands with Historical Resource Value for Palaeontology
- Initial HRIA Survey Area
- Bearpaw Formation
- Oldman Formation
- Horseshoe Canyon Formation
- Canal/Watercourse

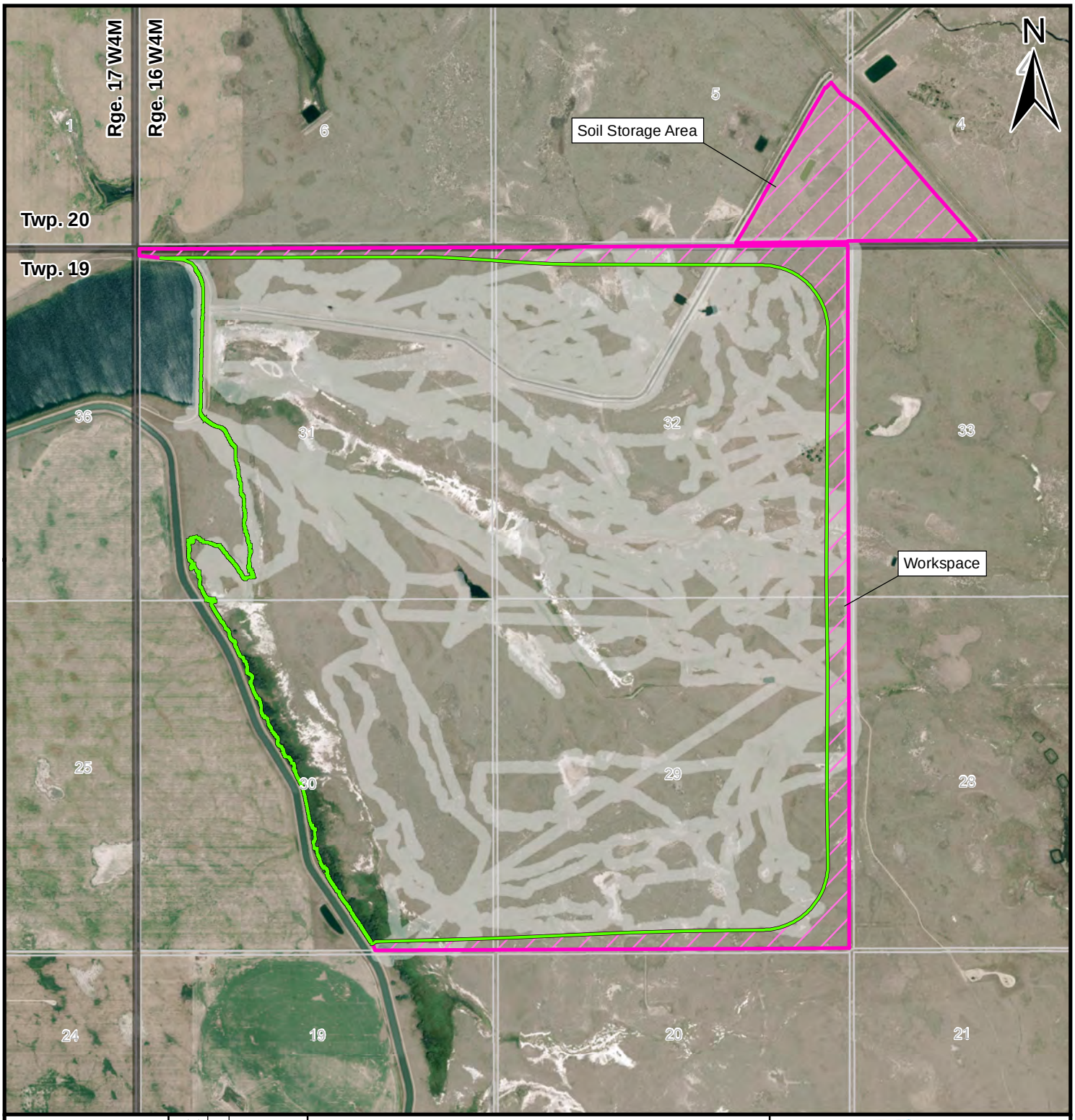
EID

Palaeontological Resources Local and Regional Study Areas

March 2025

REF.: AARES21-127 (Historical Resources)

Figure L1-2



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Drafted:	JNB	Date:	Mar 17, 2025
Approved:	WB	Revision:	0
Route Source:		Date:	July, 2021
KML		Revision:	0

Data Sources:
Imagery Reference: ESRI 2021/07/10
ATS Grid: AltaLIS 2007.

AAR Environmental Services

Please contact AARES for all other sources.

Please note that the imagery is from 2021 and although we have no reason to doubt the accuracy and completeness of it, users should be aware that discrepancies may be present

Legend

- Initial HRIA Survey Area (2021, to be inundated)
- Additional Unsurveyed Area (to be completed 2025)
- Ground Survey

EID

Historic Resources Surveyed Area to Date

March 2025

REF.: AARES21-127
(Historical Resources)

Figure L1-3