5.11 Hamlet of La Crete / Buffalo Head Prairie

5.11.1 Background

The Buffalo Head Prairie area is located south of the Hamlet of La Crete, in Mackenzie County. The area appears to be a moderate flood risk community due to reported flood issues and impacts on structures and residents. The location of the Hamlet of La Crete, and the Buffalo Head Prairie area within the Peace River Basin are shown on Figure 5-2.

5.11.2 Historical Flood and Erosion Issues

Stakeholder identified historical flood issues are shown in Figure 5-11-1. The location of each reported flood issue is numbered with a map ID and classified as high, moderate or low risk. Each issue can be found by the corresponding map ID in Table A-1 in Appendix A.

In 2013, the Buffalo Head Prairie area experienced significant snow melt which resulted in flooding. A stakeholder meeting held with Mackenzie County established that there is approximately 8,000 hectares of farm land in the area which floods annually. The spring runoff from the area flows northwest to Bear River, which then overflows its banks and floods the farmland. Through engagement with Mackenzie County, it was indicated that the flooding caused damage to public infrastructure. Additionally, it was reported that there is annual erosion issues due to fast flowing spring runoff in the area.

The County has submitted an application to AESRD's Alberta Community Resilience Program (ACRP) Grant Application. The application is for the construction of a flood control channel with retention pond in the Buffalo Head Prairie Area in order to mitigate flooding due to overland flow. The diversion channel will route overland flows west to Steephill Creek.

5.11.3 Flood Hazard Mapping

There is no flood hazard mapping available for the Hamlet of La Crete or Buffalo Head Prairie.

5.11.4 Land Use

Land use and zoning maps were requested; however, none were available at the time of this study. Most of the subject area consists of privately owned farm land located south of the Hamlet of La Crete. Some of the land is owned by the province. The Buffalo Head Prairie store is located west of Highway 697, and currently, water ponding in this area is an issue due to poor drainage. There is no land use mapping available for the Buffalo Head Prairie area.

5.11.5 Flood Mitigation Alternative

5.11.5.1 Buffalo Head Prairie Drainage Improvements Study (2014) Review

The County retained DCL Siemens Engineering Ltd. (DCL) to perform a study on the Drainage Improvements for Buffalo Head Prairie. In January 2014, an interim report, titled Buffalo Head Prairie Drainage Improvements, was submitted by DCL to Mackenzie County which included three flood mitigation alternatives. All three alternatives provided a diversion channel running from east to west towards the Steephill Creek in order to capture runoff from the upstream areas to the south, and prevent flooding of Buffalo Head Prairie area. The first two diversion channel

alignments presented in the interim report are identical, but differ in the channel slopes, and as a result the amount of required excavation differs between the alternatives. Alternative 3 presented in the interim report partially utilizes existing ditches along Highway 697 and is approximately 400 m further south than the other two mitigation alternative alignments. Additionally, Option 3 diversion alignment starts approximately 500 m west of the Bear River and crosses Highway 697. Figure 5-11-2 shows the alignment of the chosen diversion channel. In the interim report it was recommended that for all alternatives, a ponding area be provided in addition to the diversion channel in order to provide relief to the Steephill Creek during high flow events (DCL Siemens Engineering Ltd., 2014a).

Following submission of the interim report to the Mackenzie County, one alternative was chosen to proceed to preliminary design stage and a report was prepared by DCL which analysed the chosen flood mitigation method. Alternative 3 was analysed in the Buffalo Head Prairie Drainage Preliminary Design Report produced by DCL (2014b). An analysis was completed by DCL using XP-SWMM, using snow depth and melt data from the Town of High Level and the Hamlet of Fort Vermilion.

Runoff generated from a drainage area of 80 km^2 will be diverted to proposed retention pond located on the east of the Steephill Creek without having a significant impact on the Peace River Basin. Flooding and erosion will be reduced by a proposed retention pond which will have a capacity of 200,000 m^3, as reported by DCL. It should be noted that AECOM did not have access to the XP-SWMM model created by DCL for peak discharge calculation.

Design Flow Estimation

AECOM used XP-SWMM to model the estimated peak discharge conveyed in the diversion channel, modelling a combination of snowmelt and rainfall event. The estimation of April/May snowmelt peak flow and the simulation of rainfall during the snowmelt time were modeled using the XP-SWMM hydrodynamic model. The hydrological processes considered in the model are an extreme rainfall record, depression storage, surface runoff, infiltration and evaporation. The snowmelt runoff is based on an historical extreme temperature, snowmelt coefficient and snow depth record for the snowmelt season. Other initial model input parameters are specifically chosen according to basin characteristics such as delineated basin area, slope, basin wide and imperviousness ratio. The model indicated that the peak flow conveyed into the diversion channel is approximately 51.5 m^3/s. The following parameters were used to establish the peak flow:

- Total Area = 8000 ha
- Basin Width = 6200 m
- Slope = 2.5%
- Rainfall depth of 2 year 6 hour storm event in Notikewin = 34.5 mm
- Extreme temperature recorded = 32.2°C
- Extreme snow depth in April = 10 cm
- Impervious ratio = 40% (Assumes approximately 40% of the ground is frozen during snowmelt)

Diversion Channel Capacity Estimation

For the purposes of this study, AECOM used Bentley FlowMaster, a hydraulic analysis and design software, to determine whether the channel proposed by DCL is able to convey the peak flow for the Buffalo Head Prairie Area. The channel slope used in the analysis is the weighted average of the channel slopes as reported in DCL's interim report. The general cross section (3 m wide bottom, 2H:1V side slopes, and 3 m channel depth) of the channel provided in DCL's preliminary design report is unable to convey this flow, as it has a capacity of approximately 47 m^3/s. It is recommended that the cross section be increased to have 3H:1V side slopes, and a 3.5 m wide bottom. With a flow of 51.5 m^3/s, the water depth would be 2.7 m, allowing for a 0.3 m freeboard, given a total channel depth of 3 m.

5.11.6 Conceptual Cost Estimate

A conceptual cost estimate was prepared by DCL and is reported in the Buffalo Head Prairie Drainage Preliminary Design Report (2014), based on the diversion channel alternative chosen for the report. The total estimated cost for the project, including the excavation of the diversion channel, retention pond, as well as contingency and engineering fees was reported to be $6.8 million, in 2014 dollars. The total estimated cost based on AECOM's recommended channel, as described in the section above, using estimated 2015 unit rates, is in the order of $19.7 million, as summarized in Table 5-26. The cost estimate does not include the following:

- Cost to mitigate any environmental losses
- All cost associated with increased flow in the Steephill Creek, including channel improvements, erosion protection.
- Cost of utility trench and pipeline realignment
- Land acquisition/purchase
- Upgrades required for stormwater retention pond
- Additional riprap required for check dams

The cost estimate is based on the following assumptions and should be confirmed during detail design stage.

- The by-pass channel should have 3.5 m wide bottom, 3H:1V side slopes and 2 m high embankment on north and south side of the channel.
- The excavation quantities are based on 3 m cut along the by-pass channel alignment.
- 1000 mm CSP culverts are proposed at every 500 m interval, under the south berm to convey runoff into the by-pass channel.
- The channel and stormwater pond excavation unit price cost of $4/m^3 as mentioned in the preliminary report DCL Siemens Engineering seems to be on the lower side and it is recommended to use unit price indicated below.
  - $10 excavation cost for stormwater pond is based on haul distance of 2 km.
  - $7.50 excavation cost for channel excavation is based on haul distance of 4 km.

Table 5-26: Diversion Channel - Conceptual Cost Estimate

Item	Total Cost ($)
Diversion Channel	
Clearing and Grubbing	$918,000
Topsoil stripping and restoration	$459,000
Traffic accommodation and control	$60,000
Common excavation to be trucked off site and covered	$2,565,000
Preparation of channel subgrade and install vegetative cover c/w biodegradable straw mats	$4,590,000
Installation of rip-rap check dam every 400 m	$180,000
Install bank protection at ditch bend	$300,000
Upgrade culvert at Twp Rd 1044	$100,000
Upgrade culvert at Provincial Highway	$100,000
Install culverts under south berms	$780,000
Retention Pond	

Item	Total Cost ($)
Preparation of pond subgrade	$50,000
Common excavation of stormwater retention pond	$3,000,000
Sub-Total	**$14,279,500**
Mobilization & Demobilization (5%)	$714,000
Contingency (15%)	$2,142,000
Engineering (12%)	$1,714,000
GST (5%)	$800,000
Estimated Total	**$19,700,000**

5.11.7 Evaluation of DCL's Diversion Channel Alternative

DCL provided a preliminary design report for Alignment alternative 3, originally described in DCL's Buffalo Head Prairie Drainage Improvements report. This flood mitigation alternative was chosen above two other alternatives presented in DCL's Buffalo Head Prairie Drainage Improvements report, as mentioned earlier, and is the mitigation measure that the County has submitted to ACRP. Benefits of this alternative compared to the other two, are that the alignment (DCL, 2014a):

- Reduces the potential for flooding of the Buffalo Head Prairie store, located west of Highway 697, which has been an issue in the past;
- Utilizes an existing south and north drainage ditch (Buffalo Head Prairie Drainage Improvements, 2014).

5.11.8 Environmental Review of Flood Mitigation Alternative

AECOM conducted an environmental overview desktop review for proposed flood mitigation works in the Hamlet of La Crete/Buffalo Head Prairie. The purpose was to compile information on existing conditions and to provide commentary on potential permitting requirements associated with possible flood mitigation options. The desktop review consisted of examining a variety of publically available ecological databases and reports. This desktop review does not follow the format of an Environmental Impact Assessment (EIA) due to the limited engineering, hydrological, geotechnical, hydrogeological, and geological information available for the location. This is considered an environmental overview desktop report and is intended as a general guidance document outlining some of the major environmental concerns and regulatory issues associated with potential flood mitigation projects, and their surrounding area.

Various databases were searched to identify environmental factors within the Buffalo Head Prairie Area of Interest (AOI).

5.11.8.1 Wildlife and Species at Risk

Within the 20 km search radius of the Buffalo Head Prairie AOI 36 birds, two mammals, one reptile and two amphibians were listed by AESRD, Alberta *Wildlife Act*, COSEWIC, and/or SARA. In total, there are 41 species with an AESRD general status of "At Risk", "May be at Risk" or "Sensitive" and six species listed with a SARA status of "Special Concern", "Threatened" or "Endangered". These species are listed in Table 26 of Appendix D.

5.11.8.2 Fisheries

The Buffalo Head Prairie AOI includes Steephill Creek which is a Mapped Class C Water Body with a RAP of April 16th to July 15th (AESRD 2015b). There are no records of fish occurring within Steephill Creek.

5.11.8.3 Applicable Legislation

For the Buffalo Head Prairie AOI, there are a number of legislations which may be applicable to the mitigation alternative including:

- *EPEA*
- *Fisheries Act*
- *Migratory Birds Convention Act*
- *Water Act*
- *Alberta Wetland Policy*
- *Public Lands Act*
- *Historical Resources Act*
- *Provincial Parks Act*
- *Wilderness Areas Ecological Reserves, Natural Areas and Heritage Rangelands Act*
- *Alberta Wildlife Act*

See Appendix D for further detail on the Applicable Legislation for the Buffalo Head Prairie AOI.

5.11.8.4 Discussion and Summary

The following environmental elements identified in the Buffalo Head Prairie AOI:

- Boreal Forest Natural Region, Dry Mixedwood Subregion
- HRVs of 1, 4, and 5
- 14 ESAs
- Open water, fen, marsh, and swamp wetlands
- Class C Creek with RAP of April 16 – July 15
- 41 species with AESRD general listing, 6 species with SARA listing
- Migratory Bird Timing Window of April 30 – August 15
- Project submission under EPEA to determine if EIA required

Required permitting and approvals are subject to change based on the final project design. Table 27 in Appendix D summarizes potential considerations which may be required in order for the project to adhere to applicable legislation.

5.11.9 Geotechnical Review of Flood Mitigation Alternatives

5.11.9.1 Introduction

A new flood channel is proposed to reduce runoff due to snowmelt west from Highway 697 to Steephill Creek, which eventually drains into Peace River. This assessment contains a desk study of the surficial geology of the proposed alignment and highlights potential issues. Preliminary recommendations are also provided for channel stability.

5.11.9.2 Methodology

Geological maps of Alberta from the Alberta Geological Survey were consulted to determine surficial geology of the proposed alignment. Water well drilling records in the area were checked however no stratigraphic data was available from them.

5.11.9.3 Subsurface Conditions

The proposed Buffalo Head Prairie Area water diversion alignment runs primarily through organic deposits consisting of bog peat with areas of undifferentiated organic deposits ranging from woody to fibrous peat. The alignment occasionally crosses areas of glaciolacustrine deposits. It is possible that ice-thrust moraine may also be encountered along the alignment. The following sections include expected material for each deposit.

Organic Deposits

Organic deposits contain undifferentiated peat ranging from woody to fibrous peat. The organic material is commonly underlain by fine-grained, poorly drained glaciolacustrine deposits, resulting in high moisture content material. Bog peat is expected to be the primary organic deposit encountered

Bog Peat

Bog peat typically has a fluctuating water table, with sphagnum mosses, heath shrubs and stunted trees. Bog peat occurs where a fluctuation groundwater table is encountered.

Glaciolacustrine Deposits

Glaciolacustrine deposits material deposited within lakes by meltwater from glaciers. Glaciolacustrine deposits are primarily fine-grained sediments of clay in central portion of the lake and alternate layers of silty clay or silt and clay (varved clay) in peripheral zones. These deposits are compressible and very uniform in a horizontal direction.

Ice-Thrust Moraine

Ice-thrust moraine terrain results from glacial transport of originally subglacial material deposited by the glacier more or less intact. The terrain can include till, stratified drift and/or bedrock.

5.11.9.4 Discussion and Recommendations

Suitability

The presence of peat and organic material will cause problems for the construction of a drainage system along this alignment. Difficulties in mobility of construction equipment are anticipated due to the presence of weak subgrade conditions and relatively shallow groundwater levels. High groundwater levels could potentially result in various difficulties during construction including unstable excavation and difficulties with placement and compaction of fill. The organic material will not be able to be sloped and must be removed down to the underlying glaciolacustrine deposit, depending on the thickness of the organic deposit. The groundwater table is likely to be near surface or fluctuate, which will need to be controlled or drained during construction. Areas of the alignment where glaciolacustrine deposits and ice-thrust moraine are encountered may likely be suitable for construction.

Side Slopes

Till is anticipated to be encountered along the proposed channel alignment. Cut slopes in low to medium plastic clay till or clay soils up to depths of 3 m should be sloped no steeper than 2.5H:1V. If high plastic clay is encountered, cut slopes should be sloped no steeper than 5H:1V. Areas where a high water table is encountered or areas of increased sand content will require the side slopes to be flattened. Plasticity and strength parameters should be confirmed during detailed design stage. An intrusive investigation should be conducted prior to construction to confirm subsurface conditions.

Erosion

All permanent slopes should be provided with some form of erosion protection to minimize potential of scour and erosion of the slope face. Erosion control synthetic mats or rip rap, and/or topsoil and seeding with a native seed mixture should be considered.

5.11.10 Conclusions and Recommendations

Following a technical review of the information presented in the two reports by DCL, AECOM believes that in order to convey peak discharge as discussed in section 5.11.5, the cross-sectional area of the by-pass channel should be increased. The channel bottom width should be increased to 3.5 m with 3H:1V side slopes which results in a channel depth of 3.0 m (including 0.3 m of freeboard).

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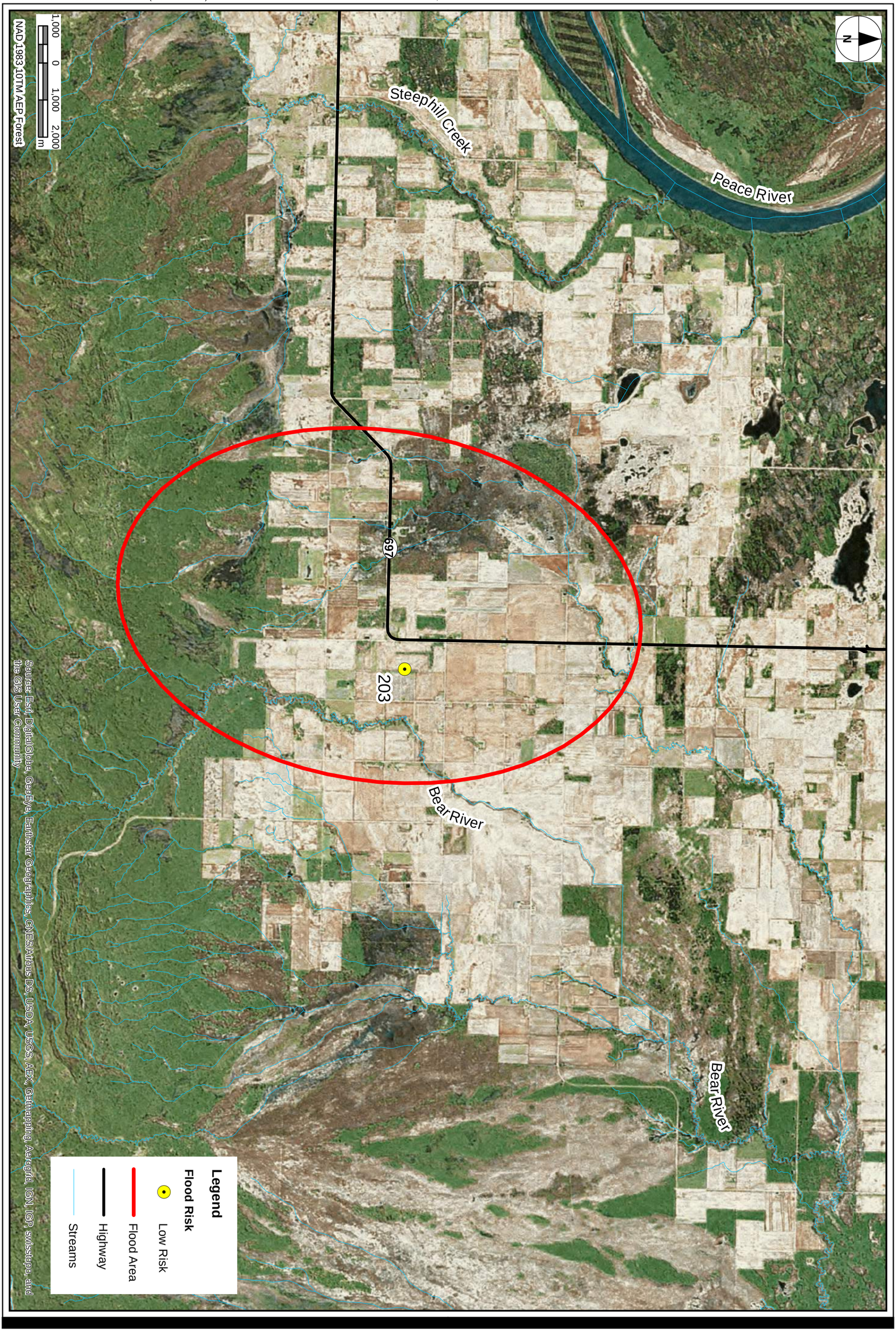
Filename: P:\60334569\900-WORK\920-929 (GIS-GRAPHICS)\MAIN REPORT FIGURES\FIGURE 5-11-1 BUFFALO HEAD PRAIRIE, MACKENZIE COUNTY - STAKEHOLDER IDENTIFIED HISTORICAL FLOOD ISSUES.MXD

ANSI B 279.4mm x 431.8mm



Peace River Basin
Flood Mitigation Feasibility Study
Alberta Environment and Sustainable Resource Development
Project No.: 60334569

Buffalo Head Prairie, Mackenzie County
Stakeholder Identified Historical Flood Issue

AECOM

Figure: 5-11-1

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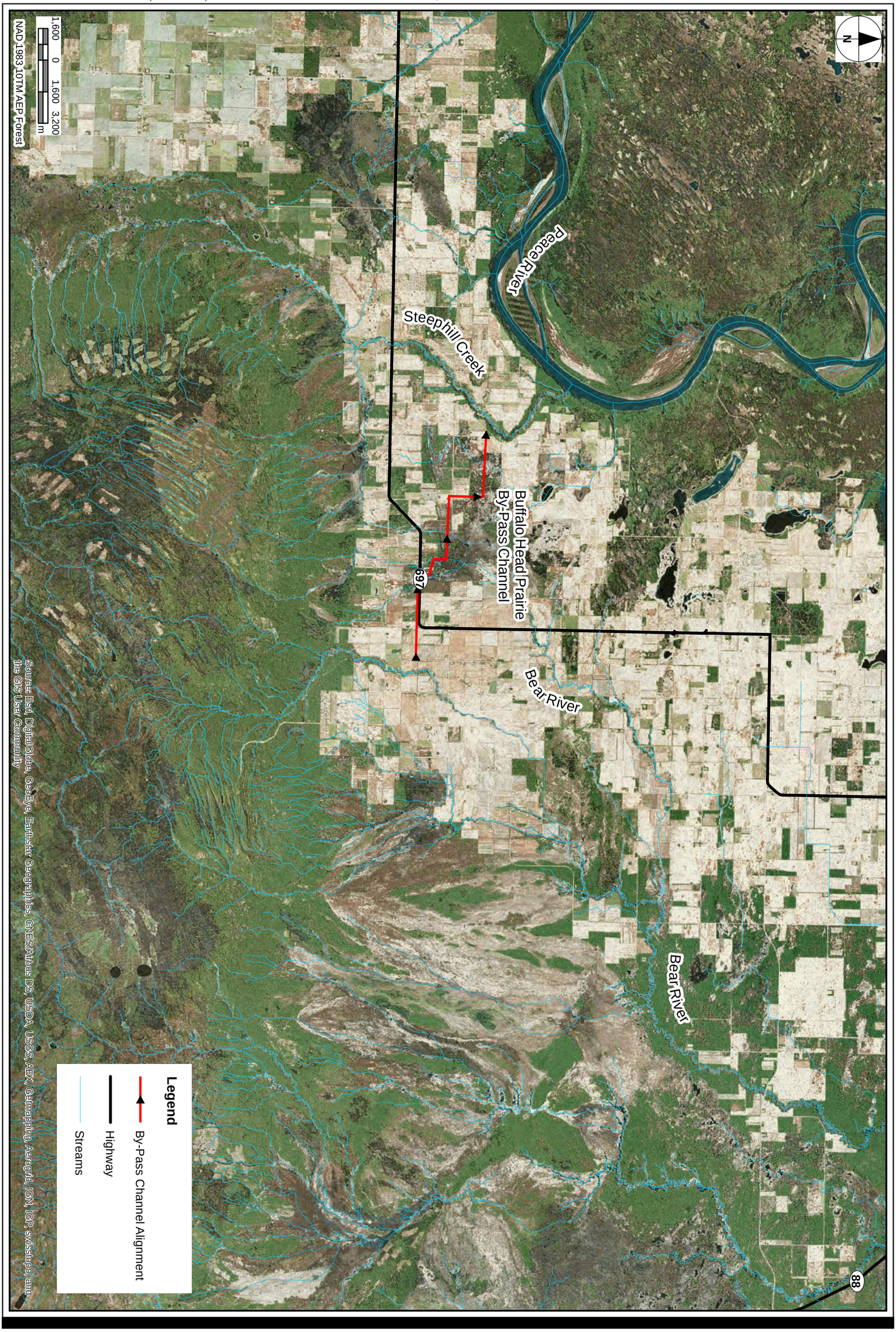
Filename: P:\60334569\900-WORK\920-929 (GIS-GRAPHICS)\MAIN REPORT FIGURES\FIGURE 5-11-2 BUFFALO HEAD PRAIRIE, MACKENZIE COUNTY - BY-PASS CHANNEL OVERVIEW.MXD

ANSI B 279.4mm x 431.8mm



Peace River Basin
Flood Mitigation Feasibility Study
Alberta Environment and Sustainable Resource Development
Project No.: 60334569

Buffalo Head Prairie, Mackenzie County
By-Pass Channel Overview

AECOM

Figure: 5-11-2