Foster Creek Thermal Project
Phase J Expansion

Application for Approval Amendment

Cenovus ENERGY

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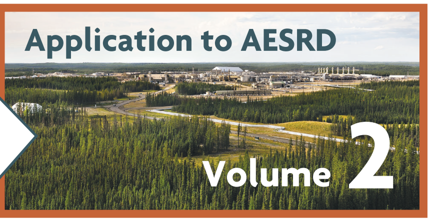

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February 2013

Matrix Solutions Inc. ENVIRONMENT & ENGINEERING

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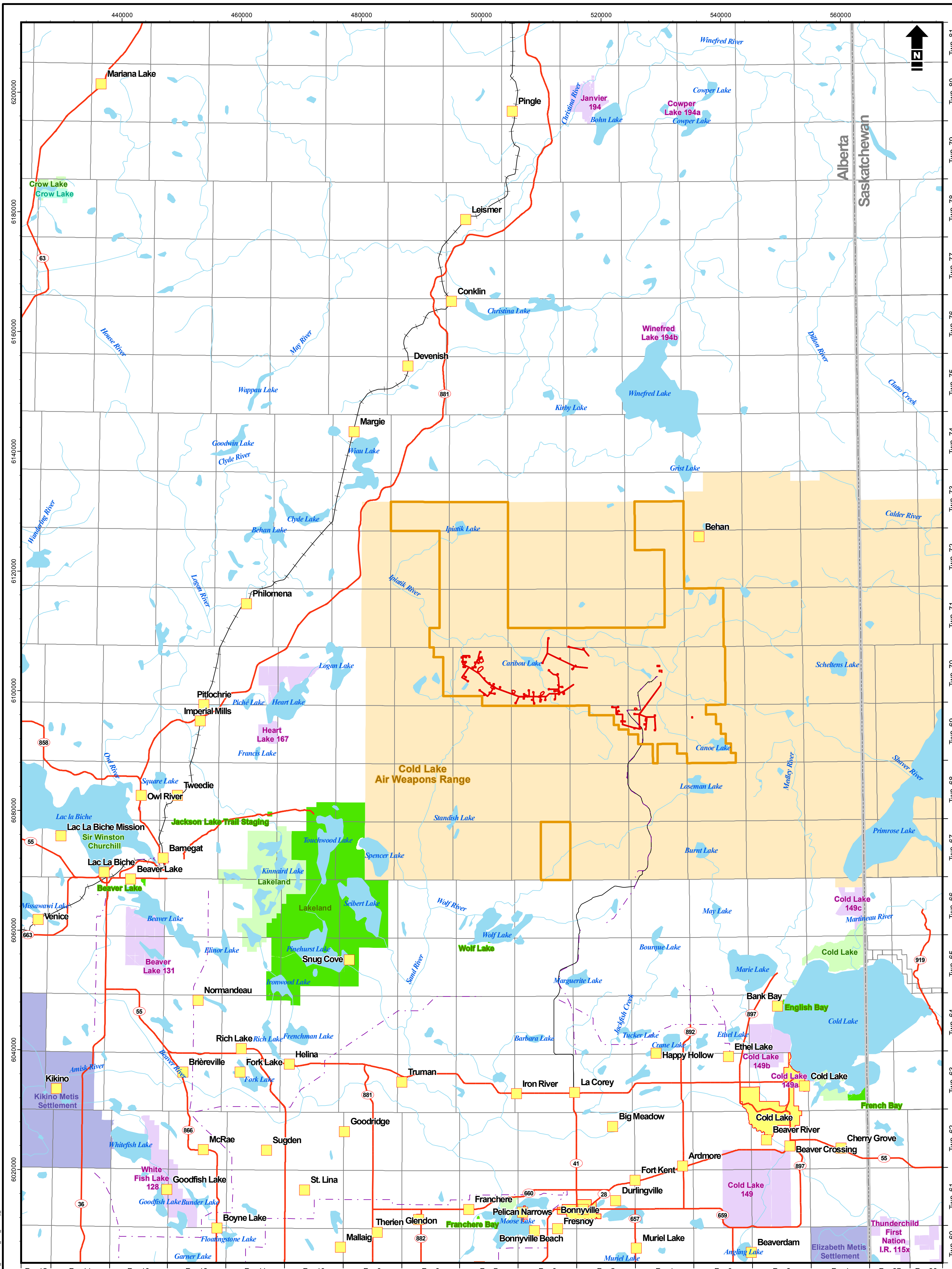
1 APPLICANT IDENTIFICATION

Cenovus FCCL Ltd. (Cenovus), as operator for the FCCL Partnership, is proposing to develop an expansion to its existing and approved Foster Creek Thermal Project (FCTP) Phase A to H facilities (EPEA Approval No. 68492-01-00). The proposed expansion, referred to as the FCTP Phase J Expansion (the Project), is located within the Cold Lake Air Weapons Range (CLAWR) approximately 90 km north of the City of Cold Lake, Alberta in Townships 69 to 71, Ranges 3 to 7, West of the Fourth Meridian (W4M). The Project location is illustrated in Figure 1-1.

Cenovus is proposing to develop the Project on its 100% owned Oil Sands Leases in north east Alberta. Steam Assisted Gravity Drainage (SAGD) in situ resource recovery technology, as utilized at the existing FCTP operations, will be employed to recover bitumen from the reservoir. With the Project, Cenovus proposes to modify and expand the Phase FGH facilities to increase the overall approved bitumen capacity from 38,271 m^3/d (240,717 bbl/d) to 46,928 m^3/d (295,165 bbl/d). This represents an incremental bitumen capacity increase of 8,657 m^3/d, or 54,448 bbl/d.

The Project central processing facility (Project CPF) includes an optimization and expansion of the approved Phase FGH CPF. The Project does not include the construction of an additional standalone CPF. Equipment to be added within the Project CPF includes bitumen processing equipment, steam generation, water processing, recycle and disposal facilities, and a cogeneration unit for electrical power and steam generation. The Project also proposes the development of additional field facilities located west and south of the existing operations. Infrastructure proposed for the field facilities include well pads, pipelines, roads and power lines.

Volume 2 has been prepared to follow the Interim Guide to Content for Industrial Approval Applications, Part 3: Amendments, and Part 1: New Facilities, where appropriate (AEW 2012). The Environmental Impact Assessment (EIA) for the Project (Volumes 3 to 6) has been prepared to follow the Guide to Preparing Environmental Impact Assessment Reports in Alberta (AENV 2011) and address the final Terms of Reference (TOR) for the Project (AESRD 2012a, Volume 3, Appendix 1A).



- Project Footprint
- Cenovus FCCL Ltd. Oil Sands Lease
- Community
- Cold Lake Air Weapons Range
- Ecological Reserve
- Indian Reserve
- Metis Settlement
- Provincial Park
- Provincial Recreation Area
- Wildland Park
- Water Body
- Watercourse
- Highway
- Road
- Railway
- Powerline

1:600,000

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Kilometres

NAD 1983 UTM Zone 12N

Reference: Data obtained from AltaLIS, GeoBase and GeoGratis. Used under license.

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Foster Creek Thermal Project Phase J Expansion

Project Location and Nearby Communities

Date: 19 Feb 2013	Project: 11029-514	Technical: B.Lamoureux	Reviewer: R.Lauzon	Drawn: C.Jackson

Disclaimer: Prepared solely for the use of Cenovus FCCL Ltd. as specified in the accompanying report. No representation of any kind is made to other parties with which Cenovus FCCL Ltd. has not entered into contract.

Figure 1-1

1.1 REGISTERED COMPANY NAME AND APPLICATION CONTACT

The registered applicant for the Project is Cenovus FCCL Ltd. (Section 1). Correspondence regarding the integrated application and EIA should be directed to the attention of:

Brent Mitchell, P.Eng.
Specialist, Regulatory Applications
Cenovus FCCL Ltd.

Telephone: (403) 766-7521
Facsimile: (403) 766-7600
E-Mail: fostercreek.expansion@cenovus.com

1.2 HEAD OFFICE AND FACILITY MAILING ADDRESS

Mailing addresses for the Cenovus head office and FCTP facility are provided in Table 1.2-1.

Table 1.2-1 Mailing Addresses

Cenovus Head Office	Cenovus FCTP Facility
Cenovus FCCL Ltd. 500 Centre Street SE PO Box 766 Calgary, AB T2P 0M5	Cenovus FCCL Ltd. Foster Creek Thermal Project Bag 1015 Bonnyville, AB T9N 2J7

1.3 TRANSFER OF APPROVAL

This application does not involve a transfer of responsibility for the existing FCTP Environmental Protection and Enhancement Act (EPEA) Approval No. 68492-01-00.

2 FACILITY IDENTIFICATION

2.1 PRIMARY ACTIVITY

The Project is a proposed expansion of an existing in situ thermal recovery project utilizing SAGD for bitumen production. The Project CPF includes an optimization and expansion of the approved Phase FGH CPF. As defined in the Activities Designation Regulation (AR 276/2003), the primary activity of the Project constitutes an “enhanced recovery in situ oil sands or heavy oil processing plant” and an “oil production site”.

Through this application, Cenovus is seeking an amendment to EPEA Approval No 68492-01-00 for the addition of equipment at the Project CPF, as well as additional well pads. The FCTP phased development history and associated regulatory approval dates are provided in Table 2.1-1.

Table 2.1-1 FCTP Phased Expansion Approval Chronology

FCTP Phase	Application Description	ERCB Approved Cumulative Capacity	ERCB Scheme Approval	AESRD EPEA Approval
Pilot	Experimental pilot project utilizing SAGD technology	N/A	8006 (Sept 1996)	68023-00-00 (March 1999)
1A	First Commercial Phase of FCTP	3,975 m^3/d (25,000 bbl/d)	8623 (June 2000)	68492-00-00 (July 2000)
1B	Phase 1 plant optimization and addition of the 80 MW cogeneration facility	5,250 m^3/d (33,000 bbl/d)	8623C (Sept 2003)	68492-00-04 (April 2002)
1C	Phase 1C plant expansion. Includes 4 additional OTSGs and central Development Area expansion.	18,025 m^3/d (113,373 bbl/d)	8623H (March 2005)	68492-00-08 (March 2005)
1D/E	Phase D/E plant expansion Includes 6 new OTSGs and Development Area expansion east of the main plant	19,080 m^3/d [1] (120,010 bbl/d)	8623I (July 2006)	68492-00-09 (Aug 2006)
1FGH	Phase FGH plant expansion. Includes 12 new OTSGs and Development Area expansion west of the main plant	38271 m^3/d [2] (240,717 bbl/d)	8623DD (Sept 2010)	68492-00-15 (July 2010)

[1] Approved capacity includes the production capacity increase application dated January 13, 2010 (ERCB Scheme Approval No. 8623S)

[2] Approved capacity includes the production capacity increase application dated July 25, 2011 (ERCB Scheme Approval No. 8623DD)

N/A = not applicable, OTSG = once through steam generator

2.2 FACILITY LOCATION

The existing FCTP is located approximately 70 km north of La Corey, 90 km northwest of the City of Cold Lake, and 90 km northeast of Lac La Biche, Alberta. The existing FCTP

Phase A-E CPF is within Sections 15, 16, 21 and 22, Township 70, Range 4 W4M, with latitude and longitude coordinates of 110°32'5.647" west and 55°4'15.453" north. Existing field facilities (e.g., well pads, access roads, borrow pits) are within Township 69, Ranges 3 and 4 W4M and Township 70, Ranges 3 to 5 W4M. The current EPEA Approval (No. 68492-01-00) definition of "plant" includes development on lands within Townships 69 to 71, Ranges 3 to 5,W4M.

The proposed Project includes an expansion of the approved Phase FGH CPF to the northeast within Section 22, Township 70, Range 4 W4M. Field facilities associated with the Project expand west and south of existing and approved facilities within Township 69, Ranges 3 to 5 W4M, Township 70, Ranges 4 to 7 W4M and Township 71, Ranges 5 and 6 W4M.

2.3 NEARBY COMMUNITIES

The FCTP is situated within the CLAWR and access within the CLAWR is limited to the Department of National Defence (DND), oil and gas activity and Aboriginal use. General public activity within this area is restricted. There are no non-industrial residents currently living within proximity of the FCTP. Through Range Access Agreements, the Cold Lake First Nations (CLFN) have access to the CLAWR for traditional uses. The relationship of the FCTP to nearby towns, cities, villages or special areas (e.g., recreation areas or camps), is presented on Figure 1-1.

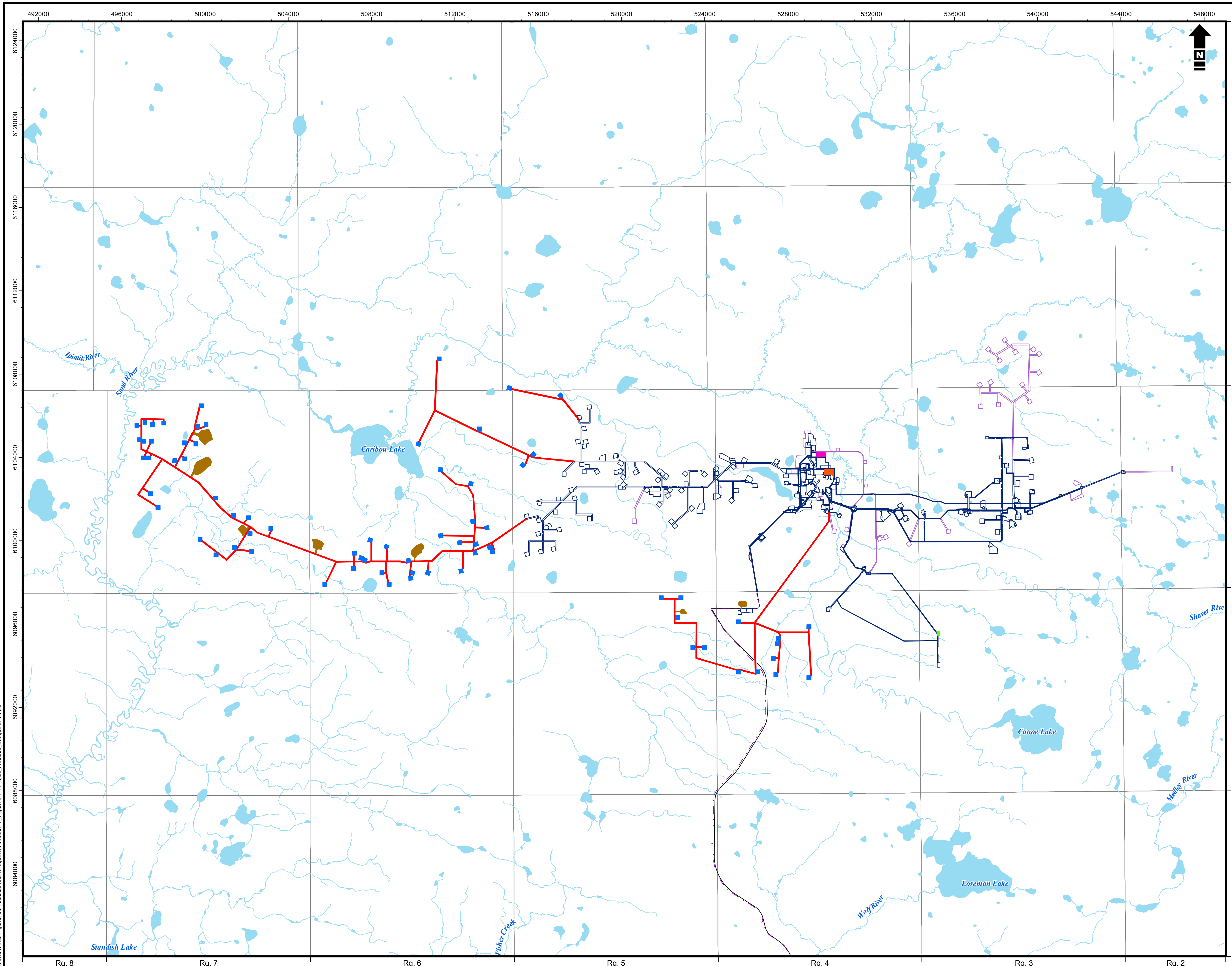
2.4 SIZE OF AFFECTED AREA

The proposed Project footprint will cover approximately 975 ha (Table 2.4-1; Figure 2.4-1), of which 57 ha has existing vegetation disturbance.

Table 2.4-1 Area of Project Footprint Components

Project Facility Type	Existing Vegetation Disturbance [1] (ha)	New Disturbance (ha)	Total Area [1] (ha)
Central Processing Facility	4	8	12
SAGD Well Pads	13	276	289
Access Roads	10	159	169
Pipeline and Utility Corridors	20	315	335
Substation	2	7	9
Disposal Well	<0.5	3	3
Borrow Areas [2]	8	150	158
Total Project Disturbance [3]	**57**	**918**	**975**

[1] Areas presented include existing disturbances where vegetation and/or soils have been disturbed by activities prior to the development of the Project.
[2] Total area designated for potential borrow; the actual excavations within these designated areas will be minimized to the extent practicable to meet Project needs.
[3] Total value might not equal the sum of the individual values, due to rounding.



Existing and Approved Development
Planned Development
Water Body
Watercourse
Road
Powerline

Project Components

Borrow Area
Disposal Well
SAGD Well Pad
CPF Expansion
Road, Pipeline and Utility Corridor
Substation

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

1:175,000

4 0 4
Kilometres

NAD 1983 UTM Zone 12N

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Foster Creek Thermal Project Phase J Expansion

Project Footprint Components

Date: 14 Feb 2013	Project: 11029-514	
Technical: B.Lamoureux	Reviewer: R.Lauzon	Drawn: R. Witty

Figure 2.4-1

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3 PROJECT BACKGROUND FOR THE PROPOSED CHANGES

3.1 GOVERNMENT APPROVED INITIATIVES

Cenovus actively participates in government approved initiatives that support responsible environmental management and resource development. Initiatives relating to the Project are listed below and discussed in Sections 4.7 and 7.3 and Volume 1, Section 11.1:

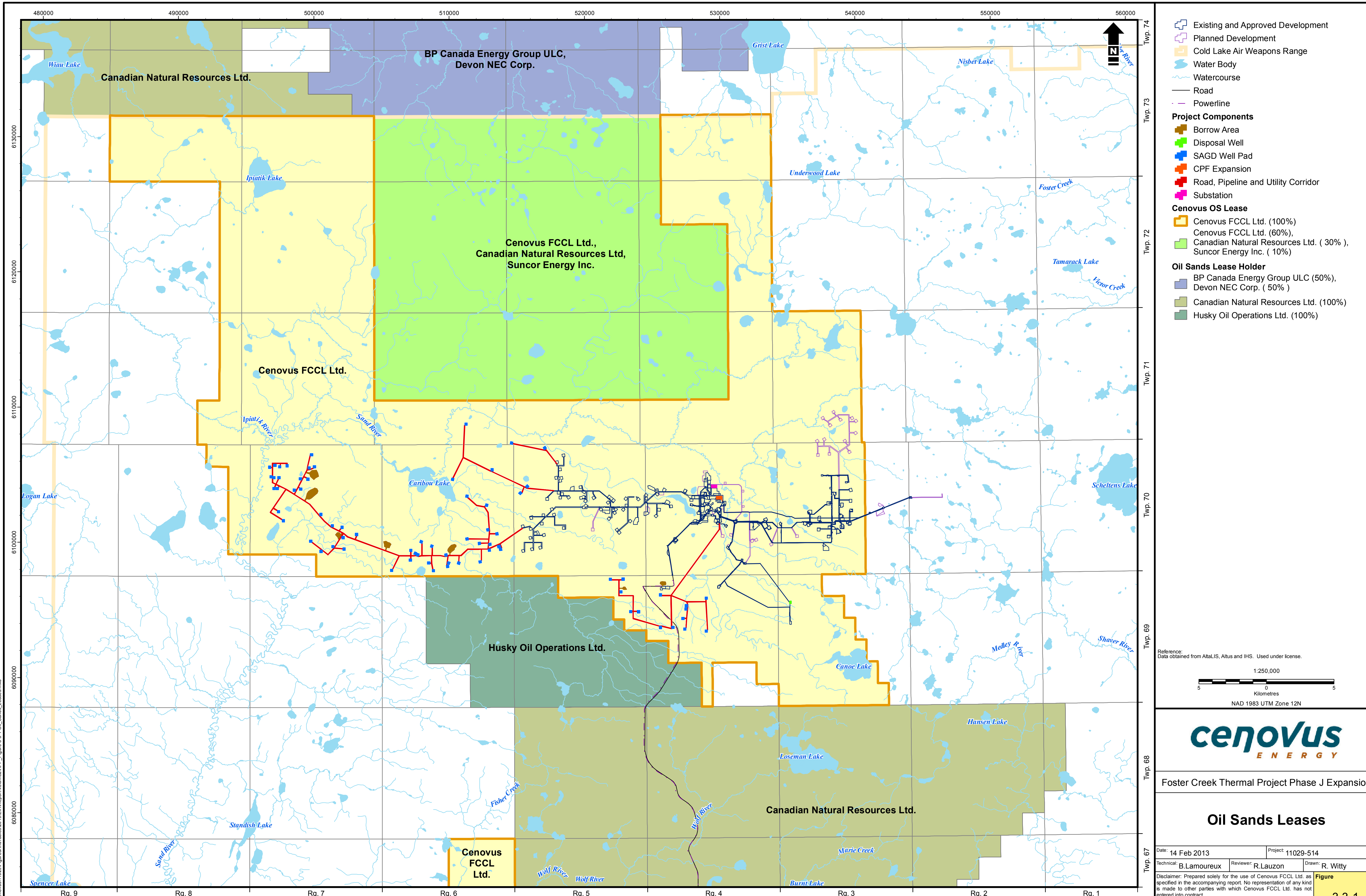
- Oil Sands Developers Group (OSDG, formerly the Regional Issues Working Group);
- Southern Athabasca Oil Sands Producers (SAOP, a committee of the OSDG);
- Alberta Chamber of Resources (ARC);
- Alberta Biodiversity Monitoring Institute (ABMI);
- Ecological Monitoring Committee for the Lower Athabasca (EMCLA, a committee of ABMI);
- Lakeland Industry and Community Association (LICA);
- Airshed Zone and Beaver River Watershed Alliance (committees of LICA);
- Land-use Framework Lower Athabasca Regional Plan (LARP);
- Canada-Alberta Oil Sands Monitoring Program; and
- Canada's Oil Sands Innovation Alliance (COSIA).

3.2 HEARING RESULTS AND ENVIRONMENTAL IMPACT ASSESSMENT ACCEPTANCE DATE

A Hearing has not occurred for the Project. The EIA for the Project is included in Volumes 3 through 6 of this integrated application.

3.3 REGULATORY AUTHORIZATIONS

The Project is located within Cenovus's 100% owned oil sands leases (Figure 3.3-1) which cover oil sands from the top of the Viking Formation to the base of the Woodbend Group. Cenovus currently holds dispositions for oil sands exploration and surface material exploration within the Project area.



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Foster Creek Thermal Project Phase J Expansion

Oil Sands Leases

Date: 14 Feb 2013 | Project: 11029-514
Technical: B.Lamoureux | Reviewer: R.Lauzon | Drawn: R. Witty

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Figure 3.3-1

3.4 PROJECT TIMELINE AND MAJOR MILESTONES

The schedule for the Project has been developed for the purposes of this application and supporting EIA, and is provided in Table 3.4-1 and in Volume 1, Section 1.5. The actual Project schedule remains subject to regulatory approval and associated conditions, company determination and market conditions.

The Project is designed to increase bitumen capacity at the FCTP by 8,657 m^3/d (54,448 bbl/d), to a total of 46,928 m^3/d, or 295,165 bbl/d. The schedule shows a Project lifespan of approximately 38 years, between 2015 and 2053. The 38-year time frame begins with commencement of construction and ends with cessation of operations. Initial SAGD well pair drilling and facilities construction will take place from 2015 to 2018, pending corporate and regulatory approvals. As initial well pads are exhausted, additional pads will be constructed to maintain the design capacity for the Project. First steam and bitumen production is scheduled to commence in 2018 and with the current definition of resource potential, operations are expected to take place for approximately 35 years. Additional resource delineation or technology improvements resulting in improved resource recovery may extend the operational life of the facility.

Decommissioning and reclamation is planned for the Project, when it is determined that a facility will no longer be required (Section 8.3.1). Interim reclamation of facilities during Project operations is also planned (Section 8.1.3). After cessation of operations, facility decommissioning and final reclamation activities will be undertaken. It is anticipated that final reclamation activities will be complete by 2059. Public consultation will be ongoing throughout the life of the Project and is discussed in Section 3.5.

Table 3.4-1 Phase J Project Schedule

Phase J Activity	Schedule
Public Consultation	Ongoing
Project Application Submission	2013 (Quarter 1)
Regulatory Approval	2015 (Quarter 1) [1]
Field Construction	2015 to 2018[1,2]
Commissioning/Start-Up (First Steam)	2018[1]
Operations	2018 to 2053[1]
Decommissioning and Final Reclamation	2053 to 2059[1,3]

[1] Target dates are based on conceptual schedule and are subject to regulatory approval, company determination and market conditions.

[2] The field construction schedule includes the construction of initial well pads to reach design capacity. As initial well pads are exhausted, additional well pads will be constructed throughout the Project lifespan to maintain design capacity.

[3] Does not include time for old growth vegetation re-establishment.

3.5 PUBLIC CONSULTATION AND STAKEHOLDER ENGAGEMENT

Cenovus will work to reduce the effects of the Project on the environment and adjacent communities. Cenovus believes in working closely with local residents and other stakeholders to help them understand the Project and to understand their concerns and potential Project effects. Cenovus recognizes the importance of building and maintaining productive relationships with communities.

Timely and meaningful dialogue with potentially affected and interested community members is integral to Cenovus's Corporate Social Responsibility Policy. The collaborative method through which Cenovus conducts engagement has regard to the needs of the local community and Cenovus's business objectives.

Cenovus's primary goal is to involve stakeholders in a meaningful way in decisions that affect them. Cenovus's principles for guiding stakeholder engagement are based on three major themes: building trust, establishing dialogue and ongoing consultation, and achieving collaboration. These principles help to identify and resolve issues, build strong communities, and support shared learning.

3.5.1 Target Audience

To conduct the consultation, stakeholders potentially affected by the Project were identified by Cenovus, and in the case of First Nations, by the Province of Alberta. Table 3.5-1 lists the various groups and organizations that Cenovus has engaged with in relation to the Project.

Table 3.5-1 List of Stakeholders

Stakeholder/Community Group	Name
First Nations	Cold Lake First Nations (CLFN)
Trappers	Registered Fur Management Holder TPA #2946 (CLFN)
Government and Service Providers	Alberta Energy Energy Resources and Conservation Board Alberta Environment and Sustainable Resource Development Improvement District 349 Lac La Biche County Department of National Defence – 4 Wing Cold Lake
Interested Communities	La Corey Bonnyville City of Cold Lake Municipal District of Bonnyville

Stakeholder/Community Group	Name
Industry	ATCO Electric Ltd. ATCO Energy Solutions Ltd. Cenovus Energy Inc. Enbridge Pipelines (Athabasca) Inc. Fortis Alberta Inc. Husky Oil Operations Ltd. Nova Gas Transmission (TCPL) Pipeline Management Inc. Telus Communications Inc.
Regional Stakeholder Working Groups	Lakeland Industry & Community Association
Provincial Government Representatives	Member of Legislative Assembly – Bonnyville/Cold Lake
Municipal Government Representatives	Mayor of the City of Cold Lake Mayor of the Town of Bonnyville Reeve of the Municipal District of Bonnyville

3.5.2 Consultation and Engagement

Cenovus conducted the consultation activities outlined below for both Aboriginal and non-Aboriginal communities. The goals of this consultation process were to increase two-way communication between Cenovus and the stakeholders, address applicable regulatory requirements, comply with stakeholders' consultation policies that are reasonable, and to continue to build relationships with potentially affected stakeholders. Cenovus has had oil operations in the area for over 10 years and in that time has established relationships with the different stakeholders potentially affected by the FCTP.

3.5.2.1 Advertising and Public Notice

In addition to direct contact with stakeholders, Cenovus used provincial and local media to advertise the various Project documents to the public. The Project's proposed terms of reference (TOR) was made public on July 10th, 2012 and was available for viewing at the following locations:

- Cenovus website: www.cenovus.com;
- Lakeland Industry & Community Association (LICA);
- ERCB Bonnyville Municipal Library;
- Cold Lake Public Library;
- Lac La Biche County Office; and
- Alberta Environment's Register of Environmental Assessment
  111 Twin Atria Building
  4999 98th Avenue

Edmonton, Alberta.

Public notice for the TOR was advertised in the following newspapers:

- Print Daily
  - Edmonton Journal;
  - Edmonton Sun;
  - Calgary Herald; and
  - Calgary Sun.

- Print Weeklies
  - Lac La Biche Post;
  - Cold Lake Sun; and
  - Bonnyville Nouvelle.

- Print Monthly
  - Alberta Sweetgrass.

Additionally, a Cenovus Local Community Relations representative provided copies of the proposed TOR directly to CLFN as well as the Plain Language Document, and Project maps.

The 45-day comment period on the proposed TOR closed on August 24, 2012, and no comments were received. Final Terms of Reference for the Project were issued on September 19, 2012.

3.5.2.2 Stakeholder Contact and Events

Cenovus employs Local Community Relations representatives to work closely with the stakeholders and their organizations to ensure that consultation objectives for the Project are met. In addition to the formal events outlined below, these individuals participate in various community events and have had additional contacts and informal meetings with many of the stakeholders potentially affected by the Project.

Cenovus hosted a community open house in La Corey, Alberta, on November 29, 2012 in order to provide the general public with the opportunity to learn about the Project. Approximately 100 people attended the event including local government representatives, landowners and regulatory officials. The objectives of the open house were to:

- present information and answer questions about the Project;
- compile a list of questions and concerns for further integration into the Project development phase;
- provide the opportunity for all stakeholders to engage Cenovus in regard to the Project in an informal, drop-in format allowing community residents to learn about the Project at their own pace; and
- present information on the AESRD and ERCB Application review processes.

The open house was advertised in the local media in both the City of Cold Lake and the Town of Bonnyville as well as on local radio stations. Social media was also used to ensure that the advertisements reached many facets of the community to ensure all residents recognized the opportunity to learn about the Project. The location of the open house was chosen in order to act as a central location to the key stakeholders potentially affected by this Project.

During the open house, there were a small number of questions and concerns associated with the Project. The majority of the questions centred around the potential local business opportunities associated with the Project, as well as the SAGD process as a whole. As the open house was held in La Corey a number of residents had concerns with traffic levels associated with the junction of provincial highways 55 and 41.

Cenovus has also been in contact with neighboring proponents and leaseholders about shared access, infrastructure and Project details. The collaboration with these stakeholders includes individual meetings and the exchange of relevant Project information.

3.5.2.3 Aboriginal Community Meetings and Consultation Work Plans

The consultation work plan developed in conjunction with CLFN focuses on the meaningful steps that are required in order to complete consultation. The work plan with CLFN includes building an understanding of the Project and identifying their issues and concerns with the proposed development.

Since April 2012, all consultation activities involving CLFN have been documented and reported to AESRD in the Bi-Monthly Consultation Report. This report includes:

- a description of how and when information was provided;
- a list of dates and locations of activities and/or meetings undertaken throughout the consultation process;
- the names of individuals and or groups contacted and where possible, list of attendees of the meetings;
- a summary of consultation efforts and outcomes including information about potentially adverse impacts on Treaty or Aboriginal rights; and
- a description of proposed follow-up with CLFN, if required.

Cenovus has engaged CLFN and their representatives to understand the path forward with regard to consultation on the Project. To date, Cenovus and CLFN Leadership and their representatives have met on several occasions in person, as well as through email and phone dialogue, and exchanged information in relation to the Project, potential impacts, and CLFN concerns. In addition to continuing consultation, Cenovus and CLFN continue to work towards developing a formal arrangement that would outline the steps for further consultation. Cenovus has provided CLFN with the proposed TOR, maps of the Project, a Plain Language Document and attended project meetings with CLFN. Meetings with CLFN Chief and Council to present the Project information were held on August 16, 2012 in Cold Lake, Alberta, and December 13, 2012, in Edmonton, Alberta.

Table 3.5-2 provides a list of meeting and events that occurred as discussed above.

Table 3.5-2 Lists of Meetings and Events – Cold Lake First Nations

Aboriginal Group or Community	Date	Meeting or Event[1]
Cold Lake First Nations (CLFN)	April 30, 2012	Consultation work plan submitted to CLFN for consideration as it pertains to the consultation for the Project.
	May 9, 2012	Request made to CLFN to initiate the traditional knowledge study process as it pertains to the proposed development area.
	May 11, 2012	Request from Chief and Council of CLFN to meet in order to discuss a course of action on the consultation for the Project.
	June 20, 2012	Meeting with the Chief of CLFN and legal representatives to discuss the path forward on consultation for the Project.
	August 16, 2012	Meeting with Chief and Council of CLFN to discuss the Phase J Expansion Project and discuss issues of concern from the community.
	December 13, 2012	Meeting with Chief and Council of CLFN to discuss further concerns associated with the Phase J Expansion Project and the identification of potential socio-economic impacts.

[1] Meetings and key milestones directly related to the Project application were included in this chart. Ongoing collective meetings were not included.

3.5.3 Identified Environmental Concerns

As a result of the stakeholder engagement process, questions and concerns were raised with respect to wildlife management, traffic volumes in the area, business opportunities, and social conditions. In particular, CLFN has advised Cenovus that they do not want any activity in their Wildlife Preservation Area and the proposed Project avoids this area. Cenovus continues to engage in consultation with local stakeholders in order to address and resolve concerns related to the Project, where practical.

As a matter of process, during formal consultation Cenovus tracks all issues raised by stakeholders and any mitigation measures undertaken by Cenovus. Cenovus uses an electronic data base to track issues and generate reports. In addition, every two months, until the Project is approved, issues and mitigation measures are reported to AESRD and CLFN.

3.5.3.1 Ongoing Consultation

Cenovus will continue with its ongoing follow-up and response to stakeholder requests as they are received throughout the regulatory process and through all stages of the Project. Copies of the application will also be made available at the following locations:

- Cold Lake First Nations Band Office;
- Bonnyville Municipal Library;
- Cold Lake Public Library;

- Alberta Environment's Register of Environmental Assessment
  111 Twin Atria Building
  4999 98th Avenue
  Edmonton, Alberta.

Additionally, copies of this application will be mailed or electronically sent to CLFN and interested stakeholders identified in Table 3.5-1.

Cenovus will use newspaper advertisements, local radio, social media and its website to provide ongoing updates to the public throughout the regulatory process. Cenovus's website will contain information about the Project through each stage in the regulatory process. The website can be found at the following link: http://www.cenovus.com and currently contains information specific to the Terms of Reference and Plain Language Description.

An email account fostercreek.expansion@cenovus.com, was created to provide the public with an opportunity to submit general inquiries as it pertains to the Project. The email is monitored regularly and all inquiries are responded to by Cenovus Local Community Relations representatives or directed to the appropriate subject matter expert.

Cenovus will also continue to comply with the approved Consultation Plan for the Project and the Consultation Guidelines. Information requests, concerns and issues from the continued interaction with CLFN will be tracked and reported in the bi-monthly report to AESRD and CLFN, and included as supplemental information to this application, as required.

4 CURRENT STATE OF THE ENVIRONMENT

This section provides a summary of the existing or baseline environmental data collected to support the Project application as required by the Interim Guide to Content for Industrial Approval Applications (AEW 2012). The information presented informs Sections 5 through 8 on the nature of environmental issues in the area and broader implications of the Project. The Baseline Cases described include consideration of the environmental effects from existing and approved projects or activities within the study areas (AENV 2011a). Additional information on the potential biophysical and socio-economic environmental effects of the Project, and mitigation measures are provided in the EIA (Volumes 3 through 6).

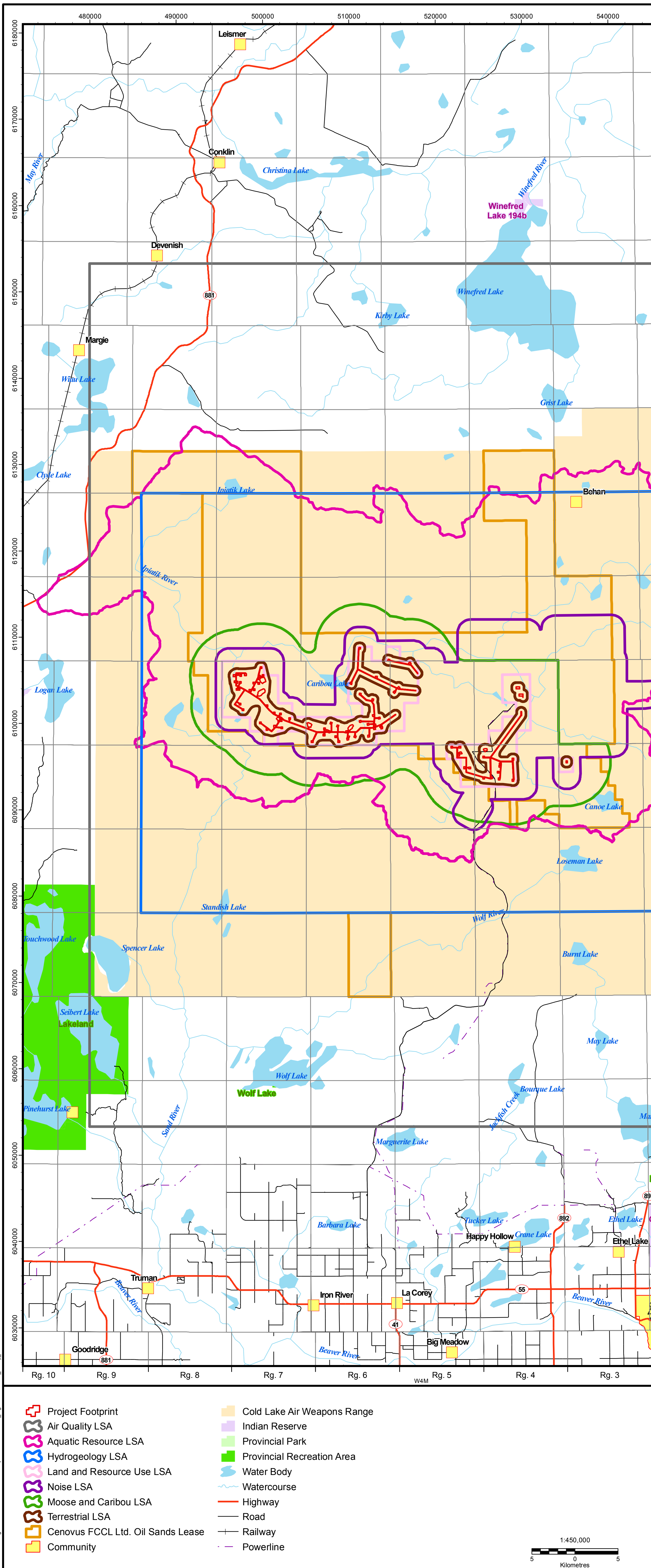
Study areas were defined for each component of the EIA and were conservatively selected to reflect the anticipated zone of influence for potential effects and pathways. For the majority of the EIA components, both a local study area (LSA) and a regional study area (RSA) were delineated to assess potential effects of the Project. The LSA is used to evaluate areas that may be directly affected by the Project development. The RSA provides a larger geographical and ecological framework to evaluate impacts of the Project in combination with other existing and planned projects or land uses. LSAs and RSAs are provided on Figures 4-1 and 4-2, respectively. Additional information on study areas is provided in the EIA Volume Introductions (Volume 4, Section 5, Aquatic Resources; Volume 5, Section 10 Terrestrial Resources; Volume 6, Section 15, Social Aspects).

4.1 SETTING

4.1.1 Landscape and Drainage

The Project is located on Crown lands within the Green Area of Alberta. Surficial geology deposits reported in the area include fluvial, glaciofluvial, organic, organic over glaciolacustrine and morainal deposits (Andriashek and Fenton 1989; Volume 5, Section 11.3.1). Surface expressions in the Terrestrial LSA include relatively level, gently sloping, undulating, and gently to strongly rolling expressions, with some ridges. Steep, inclined landforms occur in the deeply incised valleys of creeks and rivers.

The Project is within the Central Mixedwood Natural Subregion (CMNS) of the Boreal Forest Natural Region (Natural Regions Committee 2006). The CMNS contains upland forests of trembling aspen and balsam poplar in mixed and pure stands typically occurring on medium to fine textured soils. Forests dominated by jack pine mixedwood or coniferous species are commonly found on coarse textured sandy soils (Natural Regions Committee 2006). Lowland areas contain black spruce, tamarack and birch species, and typically occur on Organic soils in fens and bogs (Natural Regions Committee 2006).



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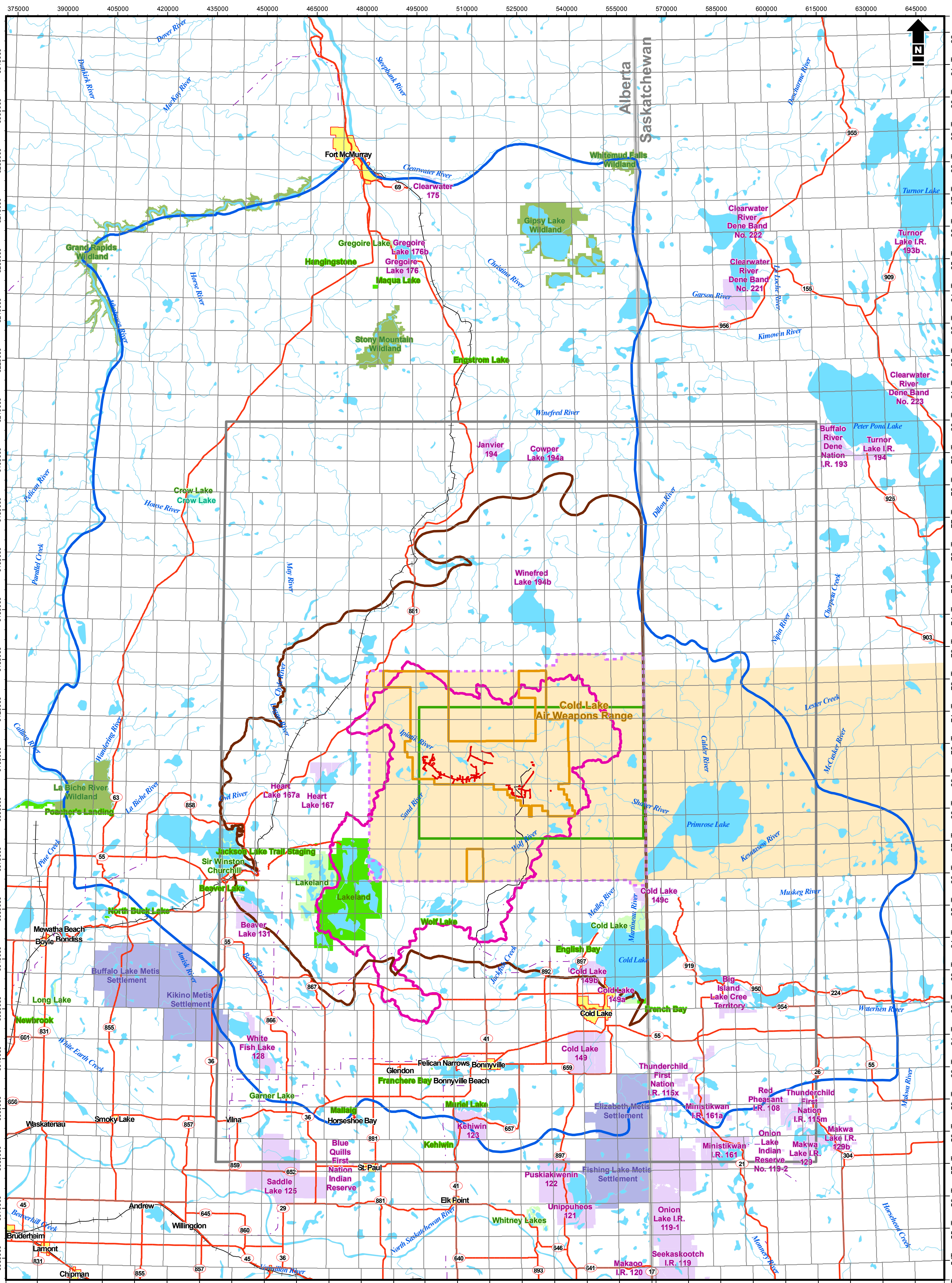
Foster Creek Thermal Project Phase J Expansion

Local Study Areas

Date: 14 Feb 2013	Project: 11029-514	Technical: B.Lamoureux	Reviewer: R.Lauzon	Drawn: C.Donihee

Disclaimer: Prepared solely for the use of Cenovus FCCL Ltd. as specified in the accompanying report. No representation of any kind is made to other parties with which Cenovus FCCL Ltd. has not entered into contract.

Figure 4-1



- Project Footprint
- Air Quality RSA
- Aquatic Resource RSA
- Hydrogeology RSA
- Land and Resource Use RSA
- Terrain and Soils RSA
- Terrestrial RSA
- Cenovus FCCL Ltd. Oil Sands Lease
- Community
- Cold Lake Air Weapons Range
- Ecological Reserve
- Indian Reserve
- Metis Settlement
- Provincial Park
- Provincial Recreation Area
- Wildland Park
- Water Body
- Watercourse
- Highway
- Railway
- Powerline

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15 0 15
Kilometres
NAD 1983 UTM Zone 12N

Reference: Data obtained from AltaLIS, GeoBase and GeoGratis. Used under license.

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Foster Creek Thermal Project Phase J Expansion

Regional Study Areas

Date: 19 Feb 2013	Project: 11029-514	Technical: B.Lamoureux	Reviewer: R.Lauzon	Drawn: C.Donihee

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Figure 4-2

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Extensive areas of northern Alberta have historically been affected by wildfire and it is the main agent of the natural disturbance regime of the Boreal Forest. A 23 ha area in the Terrestrial LSA has been affected by fire but forest regeneration is progressing. Windstorms are another natural disturbance of the Boreal Forest, but they are typically sporadic and only affect individual or small pockets of trees through windsnap (tree stem breakage) or windthrow (uprooting of trees).

The primary direction of flow (drainage) of watercourses in the Terrestrial LSA is to the northwest, as watercourses flow into the Sand River. The Sand River flows westward towards the west side of Township 70 and Range 7, where the river changes direction and flows south-southwest (Figure 4.1-1). Most of the unnamed lakes in the Terrestrial LSA drain via separate watercourses into the Sand River. Outflow from Caribou Lake is northwesterly via the Sand River.

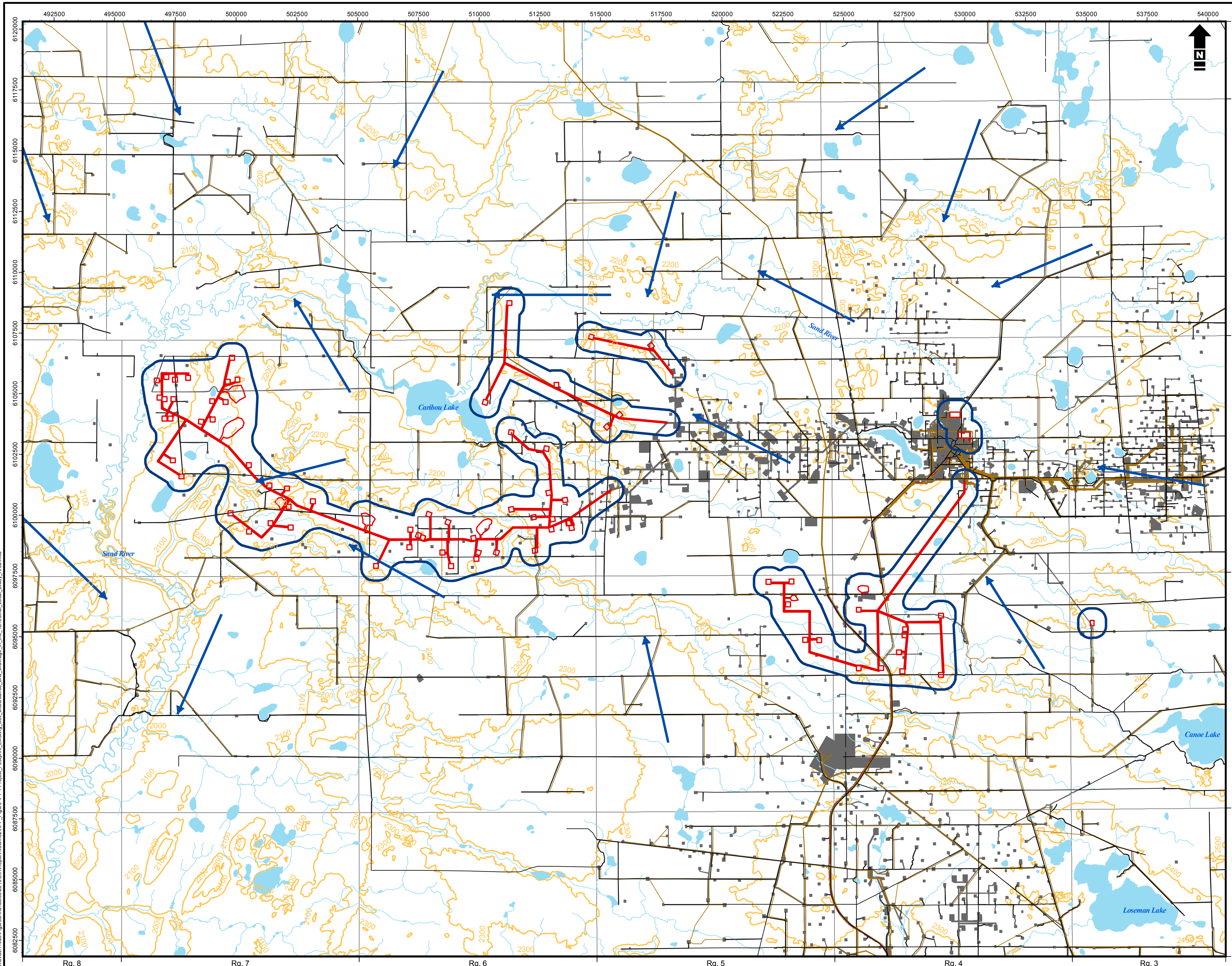
4.1.2 Existing Land Use

The Project is located within the CLAWR which has been specifically reserved for the DND's military training activities. Public activity within this area is restricted. Cenovus is party to an agreement with the DND, which gives Cenovus access for the purpose of exploring, developing and producing oil and gas resources, and for the construction of heavy oil processing facilities. Cenovus actively engages and informs the DND of its activities within the CLAWR. Through Range Access Agreements, members of the CLFN have access to the CLAWR for traditional uses. Commercial entities are provided access to the CLAWR on a case-by-case basis if a permit is provided through Range Control. Commercial fishing is permitted at Ipiatik Lake, Spencer Lake, Burnt Lake and the portion of Primrose Lake within Alberta. The Project is in Forest Management Unit L9, where there is no Forest Management Agreement (FMA) holder.

4.1.3 Groundwater

Cenovus has been monitoring groundwater at the FCTP since 1995 prior to the start-up of the pilot in 1996, and has developed a strong understanding of the local and regional geology and hydrogeology. Over this time, Cenovus has compiled a large body of data including: non-saline and saline water use volumes, wastewater disposal volumes, transient pressure data in local and regional monitoring wells and vibrating wire piezometers, and chemistry data associated with ongoing EPEA monitoring programs, as well as saline aquifer use.

Based on the planned water use associated with existing and approved projects (Baseline Case) in the RSA, regionally extensive effects to groundwater levels in saline aquifers are evident. Within the Hydrogeology LSA, the largest predicted decrease in aquifer productivity for the Baseline Case is 35% in the saline Grand Rapids D Aquifer, and the largest increase in McMurray Aquifer productivity due to injection is predicted to be 137%. Changes to water levels in non-saline Sand River and Ethel Lake aquifers in the Baseline Case were predicted to be to local in extent and of lower magnitude than in the saline aquifers.



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline
Surfacewater Flow Direction
Topography Contour (ft)
Elevation Interval = 100 ft

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

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Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Project Footprint, Existing Soil Disturbance and Drainage in the Terrestrial Local Study Area

Date: 19 Feb 2013
Project: 11029-514
Technical: R.Labbe
Reviewer: B.McNaughtan
Drawn: K.Andruchow

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Figure
4.1-1

Ongoing groundwater monitoring programs are proving to be an effective tool in managing accidental releases from existing surface facilities. To date, the extent of these effects is local to the source area as lateral migration of effects to groundwater quality is limited by the low hydraulic conductivity of the near surface till.

Some elevated groundwater temperatures have been measured in the immediate vicinity of the steam injection wells through the thermal effects groundwater monitoring program, and the lateral extent of thermal effects appears to be limited.

4.2 AIR QUALITY

From an air quality perspective, existing conditions can be defined in terms of the following parameters:

- the current air quality based on the ambient measurements conducted in the region;
- an overview of the climate conditions in the region; and
- the meteorological conditions that determine the transport and dispersion of emissions in the region.

Cenovus evaluated air quality in a 332 x 700 km Model Domain that encloses the Lower Athabasca Region (LAR). The LAR includes a large portion of the Lakeland Industry and Community Association (LICA) airshed located in the Cold Lake area and the Wood Buffalo Environmental Association (WBEA) airshed located around and to the north of Fort McMurray. The Model Domain is large enough to encompass the effects related to air emissions from the oil sands developments in the Cold Lake and Athabasca Oil Sands Areas.

4.2.1 Existing Air Quality

Continuous ambient monitoring has been conducted at 21 locations in the Model Domain: two are in rural background locations; four are near in situ operations; eleven are near conventional oil sand extraction/upgrading locations; three are within large communities; and one is near a smaller community. The continuous monitoring is complemented by a network of 41 passive sampling sites that are located varyingly near existing oil sands operations, in urban centers, and in remote rural areas.

Ambient air quality data at monitoring stations closest to the Project are collected by the LICA and industry. LICA also conducts passive monitoring, which allows for the direct measurement of long-term ambient concentrations of selected compounds. The principal compounds that are monitored by LICA through its ambient air monitoring stations and passive monitoring sites include:

- sulphur dioxide (SO_2);
- nitrogen dioxide (NO_2);
- hydrogen sulphide (H_2S);
- ground-level ozone (O_3);
- carbon monoxide (CO); and

- fine particulate matter ($PM_{2.5}$).

An examination of concentration measurements near existing in situ operations can be used to provide an indication of background concentrations that could occur near the Project. These monitoring sites include:

- WBEA Anzac monitoring station;
- Devon Jackfish compliance monitoring station; and
- LICA Maskwa station.

A summary of NO_2, SO_2, and $PM_{2.5}$ measurements collected at these stations is provided in Table 4.2-1. A range is given to represent air quality concentrations that may occur over different meteorological conditions. With the exception of $PM_{2.5}$, the maximum measured values are less than the respective Alberta Ambient Air Quality Objectives (AAAQO) and Alberta Ambient Air Quality Guidelines (AAAQG). The maximum $PM_{2.5}$ values measured at these stations are elevated due to local wildfire contributions.

Table 4.2-1 NO_2, SO_2, and $PM_{2.5}$ Measurements near Existing In situ Operations

Substance	Concentration (μg/m³)		
	1-hour	24-hour	Annual
NO_2	66 – 169 (300)	30 – 60 (none)	2.6 – 6.6 (45)
SO_2	21 – 191 (450)	6.0 – 39 (125)	0.3 – 3.4 (20)
$PM_{2.5}$	225 – 447 (80)	79.6 – 143 (30)	4.2 – 6.9 (none)

Note:
Ambient Air Quality Objectives and Alberta Ambient Air Quality Guidelines are shown in brackets.

Measured concentrations of NO_2 and SO_2 at monitoring stations near the project area are well below the AAAQO for all averaging periods. Maximum $PM_{2.5}$ concentrations are above the AAAQO and AAAQG; these exceedances are due to forest fire activity in the area. 90th percentile $PM_{2.5}$ concentrations in the region are below the respective AAAQO and AAAQG.

Maximum measured O_3 concentrations near in situ operations range from 122 μg/m³ to 171 μg/m³ relative to the AAAQO of 160 μg/m³. Maximum measured H_2S concentrations near in situ operations range from 10 μg/m³ to 17 μg/m³ relative to the AAAQO of 14 μg/m³. Measurements indicate potential for infrequent exceedance of the AAAQO for H_2S and O_3. Additional information related to the existing air quality conditions are provided in the Air Quality Assessment, Volume 3, Appendix 2B.

4.2.2 Regional Topography and Meteorology

Meteorology plays a major role in determining air quality changes downwind of industrial and non-industrial emission sources. The meteorology varies with time of day and with time of the year, and can vary from location to location due to terrain and land cover influences. The CALMET meteorological model was used to produce hourly three-dimensional meteorological fields (e.g., winds, temperatures and turbulence) for a five year period (January 1, 2002 to December 31, 2006) across the 332 by 700 km Model Domain. The CALMET model was applied using upper-level meteorological data based on meso-scale meteorological model output and on surface meteorological data from 15 stations located in the Model Domain.

Key findings regarding meteorological conditions in the Project area include:

- Surface winds measured at the Cold Lake Airport indicate a bias for westerly and easterly directions, which corresponds to the west-east orientation of the Beaver River drainage. The surface winds predicted for the Project site indicate a primary bias for westerly to northwesterly directions and a secondary bias for easterly to southeasterly winds. This bias is consistent with other monitoring in the region. While winds tend to be influenced by local terrain features, the winds predicted for the Project site appear to be representative.
- For the five-year simulation period, the annual average temperatures measured at the Cold Lake Airport for 2003, 2004 and 2005 were less than 0.5°C of the long-term mean. The annual average temperatures for 2002 and 2006 were almost 2°C warmer than the long-term mean.
- For the five-year simulation period, the annual precipitation measured at the Cold Lake Airport indicated that 2002 was a dry year, while 2003 and 2005 were wetter than the long-term mean. The annual precipitation for 2004 and 2006 were similar to the long-term mean.

The meteorological data that were used to evaluate air quality changes associated with Project emissions accounted for the seasonal and diurnal variations over a five-year period and for the spatial variations across the Model Domain due to terrain and land cover variations. The five-year period included normal and warm years, and dry, normal and wet years. The data are viewed as being representative of the wide range of weather conditions that can occur in the area.

Additional information related to the existing meteorological conditions are provided in the Air Quality Assessment, Volume 3, Appendix 2C.

4.2.3 Potential Acid Input

The deposition of acid-forming emissions on terrestrial and aquatic systems is represented by the potential acid input (PAI). Predicted PAI values are compared with the AESRD (2008) deposition framework loading criteria. These criteria refer to PAI deposition averaged over a 1° longitude x 1° latitude grid cell. This grid cell corresponds to a region that is about 64 × 112 km (7,168 km^2).

Based on the *Alberta Acid Deposition Management Framework* (AENV 2008a), the proposed Project is located in and is surrounded by grid cells that are considered sensitive to acid inputs. These areas are classified as having a “high” sensitivity. The potential effects of the predicted PAI values on soil and water chemistry will depend on the sensitivity of the receiving environment.

4.2.3.1 Baseline Potential Acid Input for Soils

At Baseline, sulphur and nitrogen emissions from existing and approved projects in the area were modeled resulting in a Baseline Case PAI deposition emissions dataset. In conjunction, critical load values were assigned to each soil map unit; higher critical load values represent soils more resistant to acidification, lower critical load values indicate soils more sensitive to acidification. The difference in the two datasets (PAI emissions minus critical load values) determines if there is a potential for a soil map unit to be at risk of acidification. This process indicates that at the locations where PAI deposition is predicted to occur, the critical loads of soils will not be exceeded in the Terrain and Soils RSA (Figure 4-2).

4.2.3.2 Baseline Potential Acid Input for Water Quality

The potential effects of the predicted PAI values on water chemistry will depend on the sensitivity of the receiving environment. Waters with alkalinity less than 20 mg/L $CaCO_3$ are generally considered to have a low acid neutralizing capacity and may be susceptible to the effects of acidification (Saffran and Trew 1996). Waters with alkalinities greater than 40 mg/L are considered to be well buffered from the effects of acidification.

Classification of the acid sensitivity of the water bodies within the Surface Water Resources LSA was based on the minimum recorded alkalinity value. Caribou, Canoe, Ipiatik, Unnamed Lake 1 and Unnamed Lake 5N were classified as having least risk of acidification (alkalinities ranged from 25 to 234 mg/L). The one sample from Underwood Lake was classified as having a low risk of acidification (alkalinity value of 25 mg/L).

Of the 40 lakes in the Surface Water Resources RSA, the majority were considered well buffered and seasonal medians ranged from 109 to 188 mg/L $CaCO_3$ (spring and winter medians, respectively). Approximately 89.0% (31 of 35) of the lakes in the Surface Water Resources RSA were classified as ‘least’ risk to acidification, and alkalinity concentrations ranged from 41 mg/L to 679 mg/L and pH values ranged from 6.5 to 8.5. Three lakes were classified as having a low risk of acidification. Unnamed Lake 3N (L-2559), Unnamed Lake 7N (L-2574) and Unnamed Lake UN-5 (L-1601) had alkalinity values from 28 mg/L to 39 mg/L $CaCO_3$. Unnamed Lake 13N (L-2562) was classified as having a moderate risk to acidification and alkalinity ranged from 12 mg/L to 14 mg/L $CaCO_3$.

4.2.4 Constraints and Limiting Factors

The Government of Alberta has established an Air Quality Management Framework as part of the Lower Athabasca Regional Plan that sets triggers and limits for NO_2 and SO_2 to provide guidance for long-term decision making and environmental management. Similarly, the Government of Alberta has also established the PM and Ozone Management Framework and the Acid Deposition Management Framework. Cenovus will consider the Lower Athabasca Region Air Quality Management Framework in the development of the Project.

Based on the Baseline Case air quality measurements, concentrations are much less than AAAQO and the exceedances that do occur are infrequent and of short duration. Maximum predicted pollutant concentrations in the Project area do not exceed AAAQOs, or regional framework action triggers. Cenovus has designed the Project to comply with the AAAQOs and to meet anticipated EPEA Approval conditions. The Air Quality Management Framework for the Lower Athabasca Region is further discussed in Section 4.7.1.1.

4.3 SOIL AND VEGETATION

The Terrestrial LSA with a 500 m zone of influence around the Project footprint was selected to incorporate potential Project effects to terrain and soils, terrestrial vegetation and wetlands, wildlife and biodiversity. The Terrestrial LSA, Project footprint, water bodies and watercourses at the Baseline Case are presented on Figure 4.1-1. Details regarding the terrestrial mapping and study approach for soils and vegetation are described in Volume 5, Sections 11 and 12.

4.3.1 Baseline Case Soils

Soil map units in the LSA are derived from the dominant soil series that occurred within the soil map unit boundaries, as well as significant soils that occurred within the boundaries (Volume 5, Appendix 11A). The dominant soil series mapped in the Project footprint and the composition of the soil map units in the Terrestrial LSA is presented in Table 4.3-1. The areas of the soil map units in the Project footprint were calculated by footprint component (Table 4.3-2).

Table 4.3-1 Extent of Soil Map Units in the Terrestrial Local Study Area

Map Unit	Dominant Series		Significant Series 1		Significant Series 2		Area of LSA (ha)	Percent of LSA
	Name	% of Unit	Name	% of Unit	Name	% of Unit		
SCA[1] 20								
aaBMT-1	aaBitumount	60	LIZ	10-20	SLN	0-10	105	0.9
aaBMT-2	aaBitumount	60	LIZ	20-40	SLN	0-10	220	1.8
aaMUS-1	aaMuskeg	60	BLA	20-40	aaSTP	0-20	13	0.1
aaSTP-1	aaSteepbank	60	ABC	10-30	SLN	10	272	2.2
SCA[1] 21								
ABC-1	Athabasca	60	MHL	10-30	LIZ	10-30	2,608	21.6
ABC-2	Athabasca	60	aaSTP	10-30	aa,ptSTP	10-30	697	5.8
BLA-1	Birkland	60	aaBMT	10-30	aaSTP	10-30	129	1.1
LIZ-1	Liza	60	MHL	10-30	ABC	10-30	1,699	14.1
MHL-1	Moose Hills	60	ABC	20-40	LIZ	0-20	1,592	13.2
SBN-1	Stebbing	60	SLN	0-40	aaSTP	0-40	2,404	19.9
SLN-1	St. Lina	60	aaSTP	0-40	aaBMT	0-40	1,051	8.7
SLN-2	St. Lina	60	SBN	0-30	aaSTP	0-20	248	2.1
Sub-total							**11,038**	**91.4**
Non-soil units (water, facilities, unclassified, existing disturbance)							1,037	8.6
Total[2]							**12,075**	**100.0**

Notes: aa – not modal soil in the soil correlation area; pt – an organic horizon that is greater than 10 cm thick
[1] SCA – Soil Correlation Area (ASIC 2006).
[2] Total value might not equal the sum of the values, due to rounding.

Table 4.3-2 Main Soil Map Units in the Project Footprint by Footprint Component

	Area by Soil Map Unit in hectares for each Facility Component and Percent Area								
Soil Map Units	CPF Expansion	SAGD Well Pads	Access Roads	Pipeline and Utility Corridors	Sub-station	Disposal Well	Borrow Areas	Total[1]	% of Foot-print
Mineral Soils									
ABC-1		61.9	35.9	71.8			32.2	**201.8**	**20.7**
ABC-2		21.1	15.2	29.9			19.4	**85.7**	**8.8**
aaBMT-2		1.9	4.1	7.9				**13.9**	**1.4**
LIZ-1	10.1	60.1	21.4	41.9	4.4		56.4	**194.2**	**19.9**
MHL-1		31.6	20.5	40.3		2.9	37.2	**132.5**	**13.6**
aaSTP-1		7.4	5.3	10.5			0.4	**23.6**	**2.4**
Subtotal [1]	***10.1***	***184.0***	***102.4***	***202.3***	***4.4***	***2.9***	***145.5***	***651.7***	***66.9***
Organic Soils									
BLA-1		3.6	1.4	2.8			0.1	**7.9**	**0.8**
aaMUS-1		0.3	0.5	1.0				**1.7**	**0.2**
SBN-1		48.8	37.2	74.5			7.9	**168.5**	**17.3**
SLN-1		37.7	16.9	34.2	3.9			**92.7**	**9.5**
SLN-2		8.8	3.2	6.4				**18.5**	**1.9**
Subtotal [1]		***99.2***	***59.2***	***118.9***	***3.9***		***8.0***	***289.2***	***29.7***
Other									
Disturbances	1.6	5.6	6.2	10.4	0.9	0.2	4.3	**29.3**	**3.0**
Water, SC			1.5	3.0				**4.4**	**0.5**
Subtotal [1]	***1.6***	***5.6***	***7.7***	***13.4***	***0.9***	***0.2***	***4.3***	***33.7***	***3.5***
Total [1]	**11.7**	**288.8**	**169.3**	**334.6**	**9.2**	**3.1**	**157.8**	**974.6**	**100.0**

1. Total value might not equal the sum of the individual values, due to rounding.

Not all of the soil map units in the Terrestrial LSA are present in the Project footprint. The proportion of the Project footprint in upland mineral soil (non-Organic) is 66.9% and in Organic soils is 30%. The Athabasca soils map units (SMUs) are the most common mineral soil and are mapped on 28.3% of the Project footprint. The coarser textured aaBitumount and Moose Hill soils are primarily developed on coarse glaciofluvial deposits and comprise 15% of the footprint. The coarse textured Liza SMUs developed on glaciofluvial deposits comprise 21.1% of the Project footprint. The Liza soil is most extensive at the south and west ends of the Terrestrial LSA. The Gleysolic soils, aaBitumount and aaSteepbank occur in wet, low areas in uplands, or they are transitional between the mineral soils and the Organic soils.

The Muskeg and the Stebbing Organic soils were classified as having a peat thickness equal to or greater than 160 cm, while the Birkland and St. Lina Organic soils were classified as having a peat thickness of 40 cm to 159 cm. The distribution of the SMUs in the LSA is presented in Volume 5, Section 11, Terrain and Soils.

4.3.1.1 Soil Suitability for Reclamation

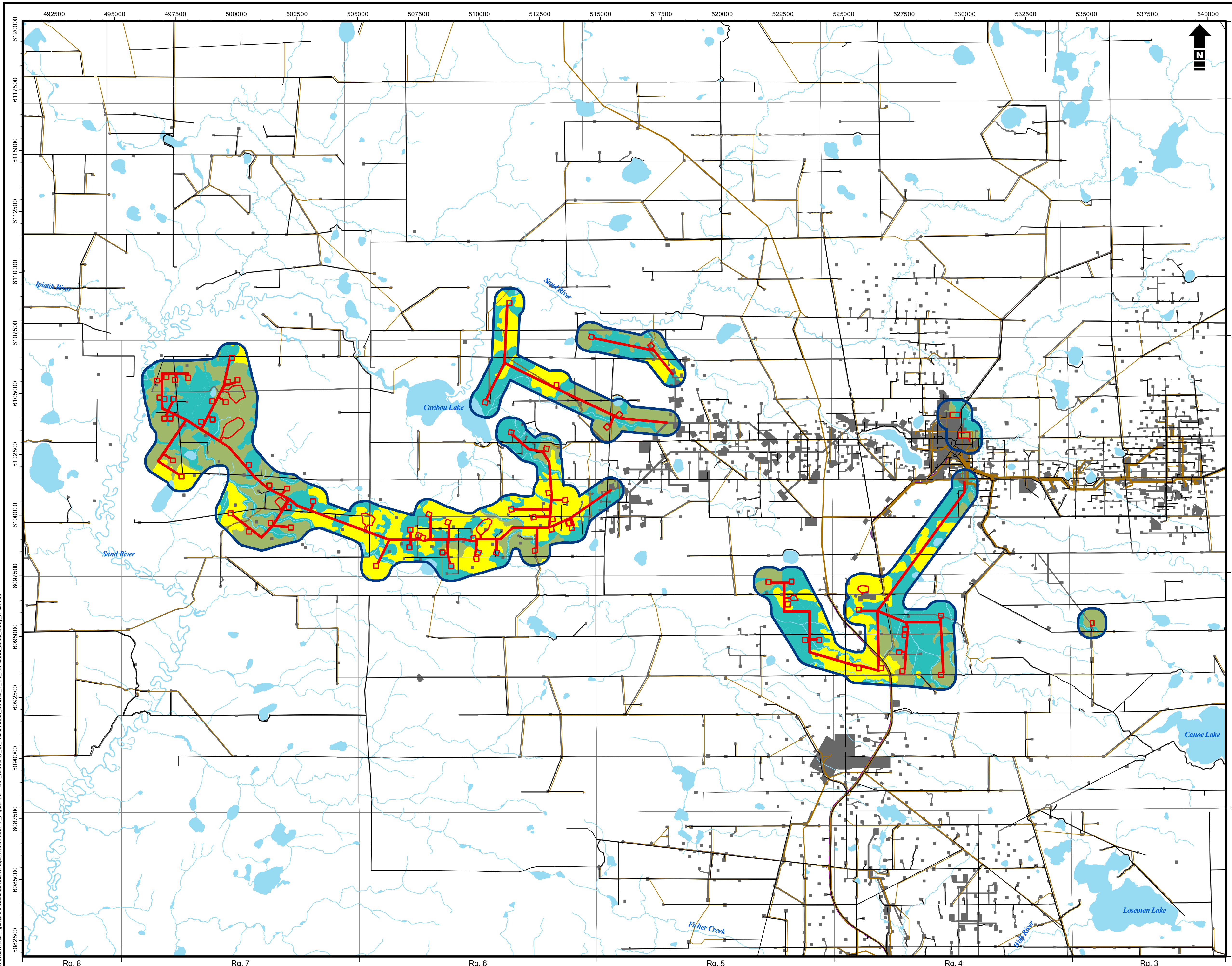
Reclamation suitability ratings for topsoil (upper lift) and subsoil (lower lift) materials were determined for each of the soil series in the Terrestrial LSA. The ratings, as defined in *Soil*

Quality Criteria Relative to Disturbance and Reclamation (Alberta Agriculture, Food and Rural Development [AAFRD] 1987), were applied to the surface and subsurface mineral soils (Table 4.3-3; Figure 4.3-1 and Figure 4.3-2) and are not applicable for Organic soils (AAFRD 1987). The criteria for rating the suitability for reclamation of surface and subsurface soils in the Northern Forest Region of Alberta are described in SQCRDR (AAFRD 1987) and are presented in the EIA (Volume 5, Section 11, Terrain and Soils). Soils rated good or fair for reclamation suitability are expected to respond well to reclamation.

Table 4.3-3 Reclamation Suitability of Soils in the Terrestrial Local Study Area

Soil Map Units	Surface Reclamation Suitability Class	Limitations	Subsoil Reclamation Suitability Class	Limitations
ABC-1, ABC-2	Fair	Acidic reaction	Fair	Acidic reaction, texture
aaBMT-1, aaBMT 2	Not rated	Surface peat	Poor	Acidic reaction, coarse texture, moist consistence
BLA-1	Not rated	--	Not rated	--
LIZ-1	Poor	Acidic reaction, coarse texture, moist consistence	Poor	Acidic reaction, coarse texture, % saturation, moist consistence
MHL-1	Poor	Acidic reaction	Fair	Acidic reaction, moist consistence
aaMUS	Not rated	--	Not rated	--
SBN-1	Not rated	--	Not rated	--
SLN-1, SLN-2	Not rated	--	Not rated	--
aaSTP-1	Not rated	Surface peat	Fair	Fine texture

The Gleysolic soils (aaBitumount and the aaSteepbank) are often characterized by surface peat layers and relatively thin or absent "A" horizons; hence, the surface horizon of these SMUs have a surface peat limitation and were not rated for reclamation suitability. Acidity and the sandy texture of the topsoil and subsoil of the Liza soil series and the sandy subsoil of aaBitumount strongly influence the rating of poor for reclamation suitability. The extent of the reclamation suitability classes in the Terrestrial LSA (Table 4.3-4) was determined from the ratings assigned to the soil map units.



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline

Reclamation Suitability
Fair
Poor
Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

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Kilometres
NAD 1983 UTM Zone 12N

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Foster Creek Thermal Project Phase J Expansion

Soil Suitability for Reclamation (Surface) in the Terrestrial Local Study Area

Date: 19 Feb 2013 | Project: 11029-514
Technical: R.Labbe | Reviewer: B.McNaughtan | Drawn: K.Andruchow

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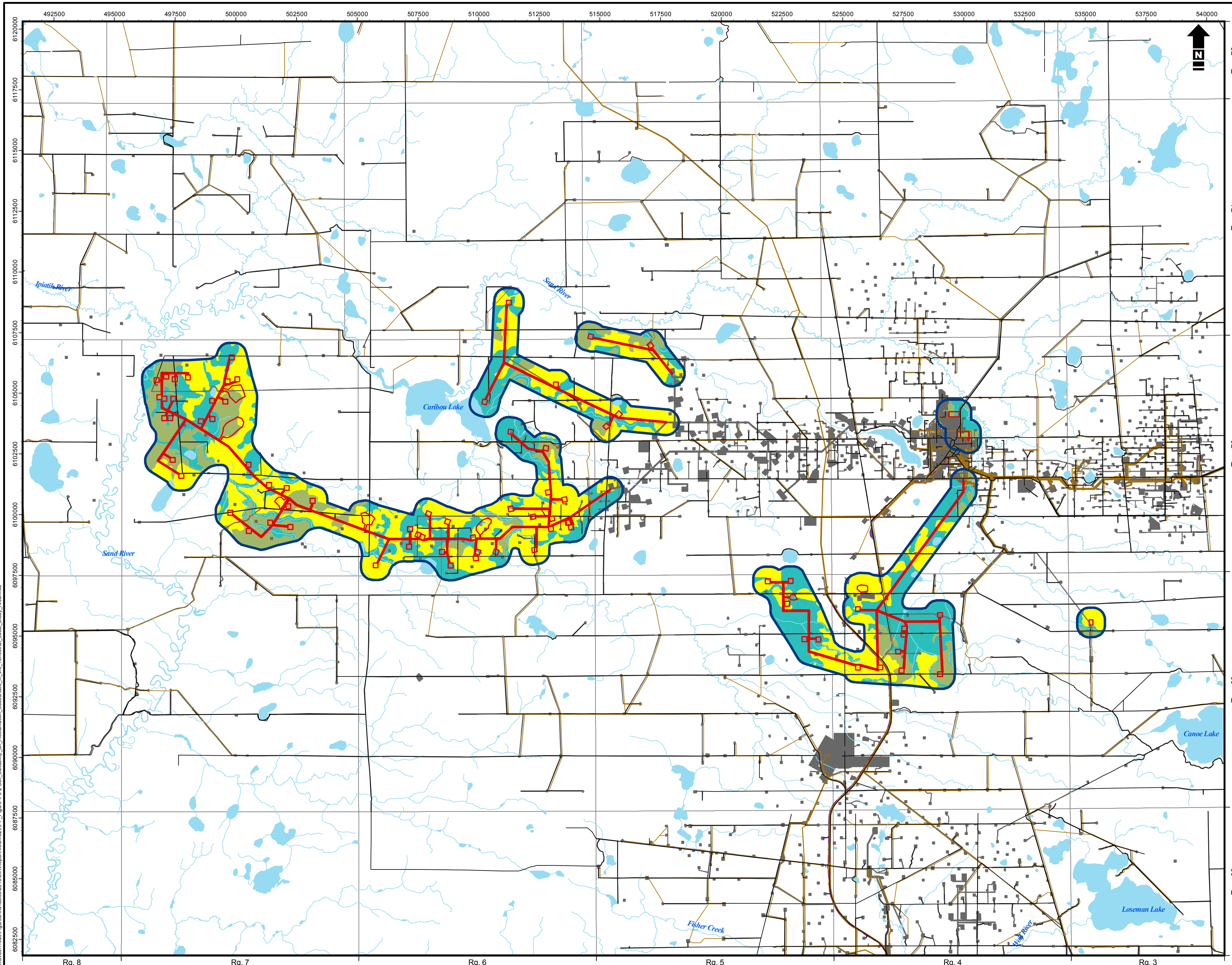
Figure 4.3-1



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline

Reclamation Suitability

Fair
Poor
Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

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Kilometres

NAD 1983 UTM Zone 12N

Foster Creek Thermal Project Phase J Expansion

Soil Suitability for Reclamation (Subsurface) in the Terrestrial Local Study Area

Date: 19 Feb 2013 | Project: 11029-514

Technical: R.Labbe | Reviewer: B.McNaughtan | Drawn: K.Andruchow

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Figure 4.3-2

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Table 4.3-4 Extent of Reclamation Suitability Classes for Mineral Soils in the Terrestrial Local Study Area

Reclamation Suitability Class	Surface		Subsurface[1]	
	Area (ha)	Percent of Terrestrial LSA	Area (ha)	Percent of Terrestrial LSA
Good	0	0.0	0	0.0
Fair	3,305	27.3	5,222	43.2
Poor	3,291	27.3	1,971	16.4
Subtotal [2]	**6,596**	**54.6**	**7,193**	**59.6**
Organic soil and surface peat of Gleysolic soils	4,442	36.8	3,845	31.8
Non-soil units (water, stream channels, facilities, unclassified, existing disturbance)	1,037	8.6	1,037	8.6
Total [2]	**12,075**	**100.0**	**12,075**	**100.0**

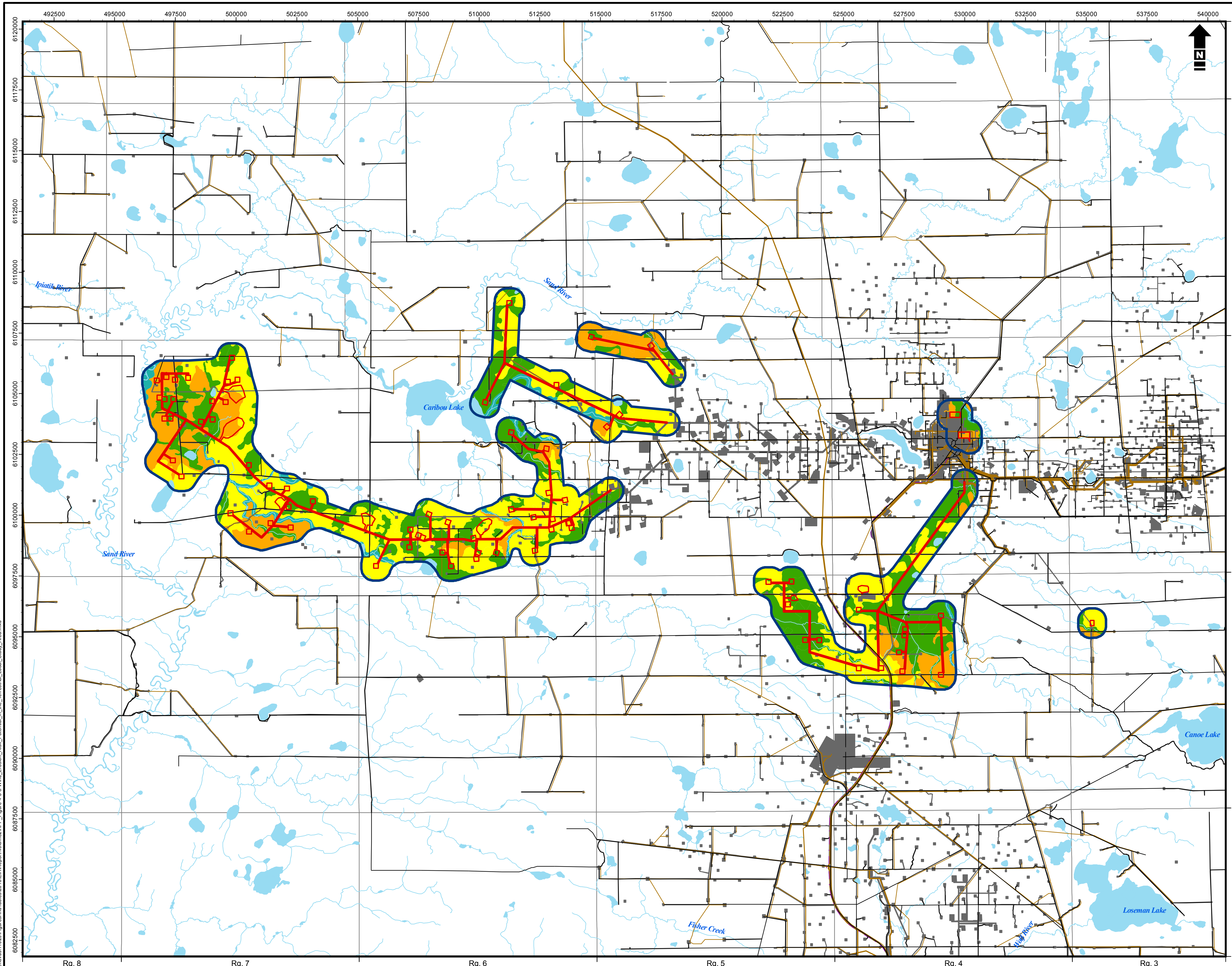
1. Subsurface reclamation suitability ratings include all mineral soil SMUs, including Gleysolic soils.
2. Total value might not equal the sum of the individual values, due to rounding.

4.3.1.2 Risk to Wind and Water Erosion

The risk of erosion due to wind is dependent on texture and exposure of the soil surface to wind (Coote and Pettapiece 1989; Pedocan 1993). The risk of water erosion is positively associated with increasing slope length and steepness, but is mitigated by vegetative cover (Pedocan 1993; Tajek and Coote 1993). Erosion risk ratings for wind and water were determined for each soil series (Table 4.3-5; Figure 4.3-3 and Figure 4.3-4).

Table 4.3-5 Risk of Soils to Wind and Water Erosion in the Terrestrial Local Study Area

Soil Series	Risk to Wind Erosion	Risk to Water Erosion
Athabasca	Moderate	Slope dependent: Low <5%, Moderate 5-9%, High >9%
Birkland	Low	Low
aaBitumount	High	Low
Liza	High	Slope dependent: Low <5%, Moderate 5-9%, High >9%
Moose Hills	Moderate	Moderate
aaMuskeg	Low	Low
Stebbing	Low	Low
St. Lina	Low	Low
aaSteepbank	Low	Low



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline

Sensitivity to Wind Erosion

High
Moderate
Low
Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

1:150,000

4 0 4

Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Wind Erosion Risk Potential in the Terrestrial Local Study Area

Date: 19 Feb 2013
Project: 11029-514
Technical: R.Labbe
Reviewer: B.McNaughtan
Drawn: K.Andruchow

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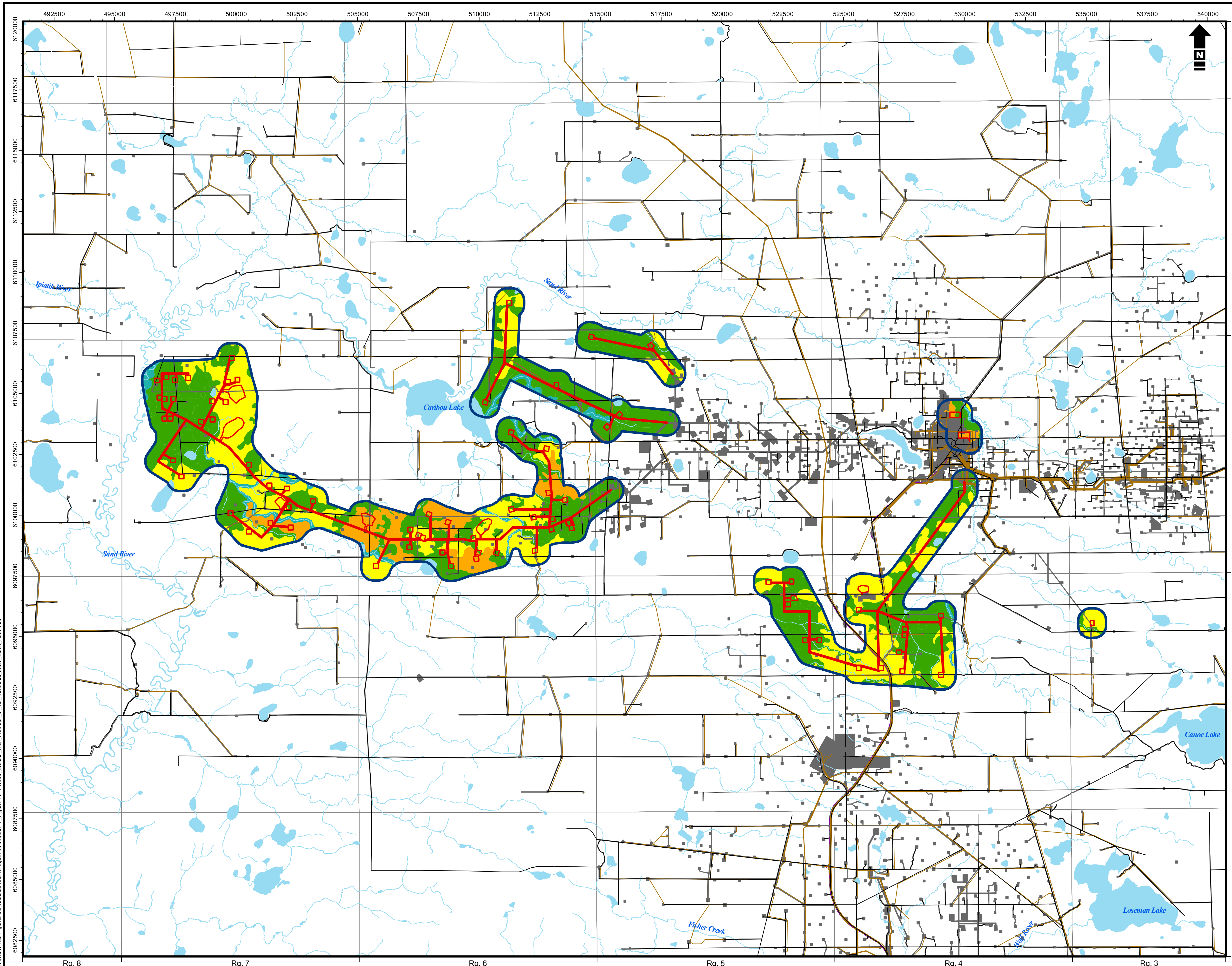
Figure 4.3-3



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline

Sensitivity to Water Erosion

High
Moderate
Low
Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

1:150,000

4 0 4
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Water Erosion Risk Potential in the Terrestrial Local Study Area

Date: 19 Feb 2013	Project: 11029-514	
Technical: R.Labbe	Reviewer: B.McNaughtan	Drawn: K.Andruchow

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Figure 4.3-4

I:\Cenovus\11029\Figures\AndTables\2010\EIA\Report\Volume2\APP_Figure-4-3-4-Water_Erosion_Risk_Potential_in_the_Terrestrial_Local_Study_Area.mxd

Mineral soils with loamy to clay soil textures (aaSteepbank) are estimated to have a relatively low wind erosion potential. Conversely, soils with a high sand content (Liza, aaBitumount) have higher wind erosion potential. The Athabasca and Moose Hills soil series had lower topsoil sand content and were subject to moderate wind erosion risk. The poor reclamation suitability and the wind erosion risk associated with the Liza and aaBitumount soils means that these soils have a greater sensitivity to soil handling and replacement.

The Organic soils and the Gleysolic soils were rated as having low wind and water erosion risk due to their level topography and moist condition, unless the soil face is exposed or dried (e.g., excavated).

Slope gradient affects the risk for water erosion in all cases. During the soil surveys, a large variation in surface expression and slope gradient was observed across the landscape. Slope dependent ratings (low, moderate and high water erosion risk) were only assigned to Athabasca and Liza soil series because they were observed in level or inclined to hummocky, terraced or rolling topography. The Moose Hills soil series was given a moderate water erosion risk because it occurred on slopes between 6 and 9%. Table 4.3-6 presents a summary of the extent of wind and water erosion risks (assuming no vegetative cover) in the Terrestrial LSA.

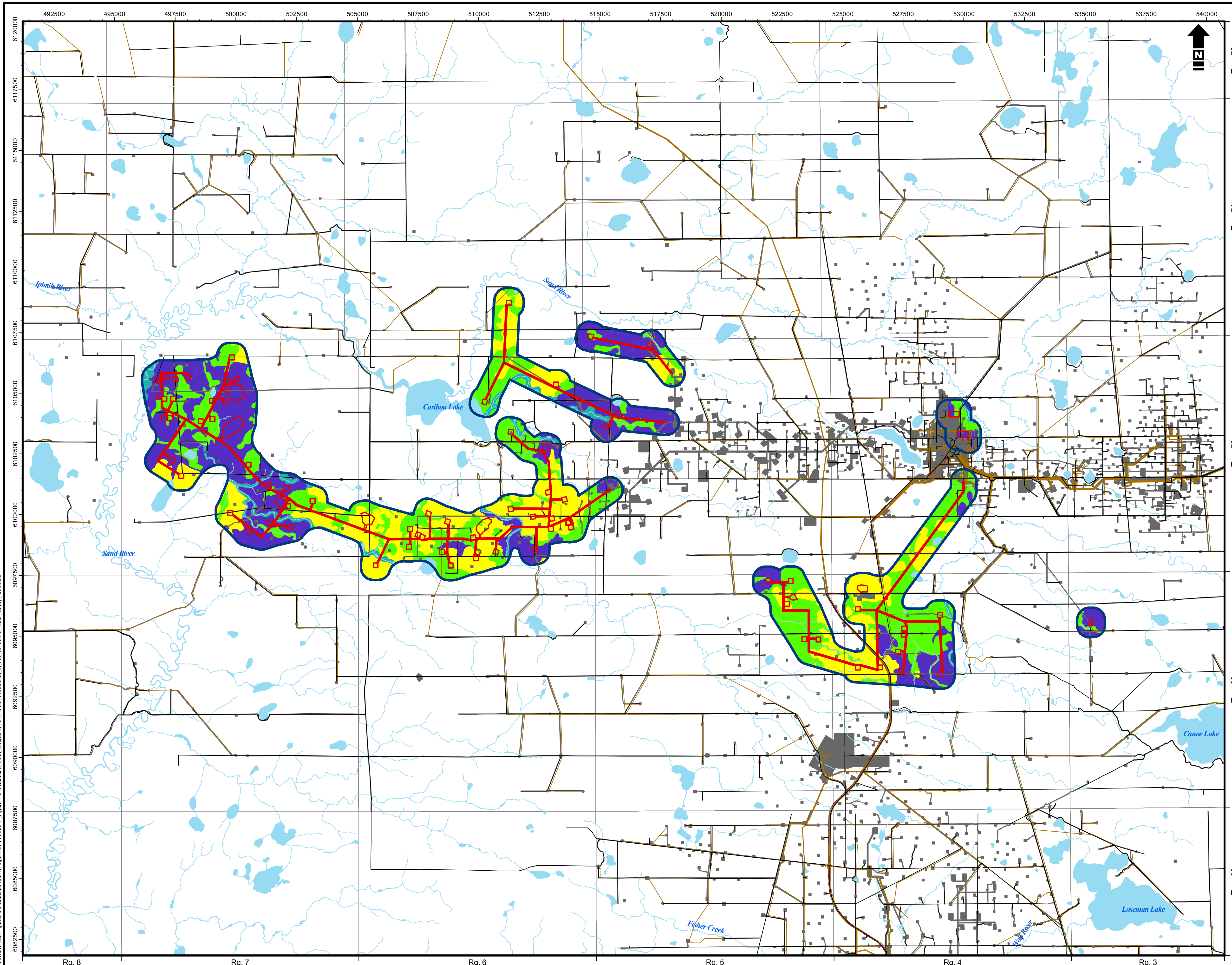
Table 4.3-6 Extent of Wind and Water Erosion Risks in the Terrestrial Local Study Area

Wind Erosion Rating	Wind Erosion		Water Erosion Rating	Water Erosion	
	Area (ha)	Proportion of Terrestrial LSA (%)		Area (ha)	Proportion of Terrestrial LSA (%)
Low	4,117	34.1	Low	6,192	51.3
Moderate	4,897	40.5	Moderate	3,872	32.1
High	2,024	16.8	High	974	8.0
Water, lakes, roads, existing disturbances	1,037	8.6	Water, lakes, roads, existing disturbances	1,037	8.6
Total [1]	**12,075**	**100.0**	**Total**	**12,075**	**100.0**

[1]. Total value might not equal the sum of the individual values, due to rounding.

4.3.1.3 Land Capability Classification Rating and Distribution

The Land Capability Classification System (LCCS) for Forest Ecosystems ratings were assigned to the soil map units based on terrain and soil physical and analytical information obtained through field inspections and laboratory analyses of soil samples (Volume 5, Section 11, Terrain and Soils). The LCCS is a tool that is useful for estimating moisture and nutrient regimes of reclaimed soils, and this information is then useful in identifying the target ecosites and corresponding native species for revegetation (Section 8.4.1). The areas and distribution of the LCCS classes at the Baseline Case in the Terrestrial LSA are shown in Table 4.3-7 and illustrated on Figure 4.3-5.



Project Footprint
Terrestrial LSA
Soils Baseline Disturbance
Water Body
Watercourse
Road
Pipeline
Powerline

Land Capability Class

3 (Low)
4 (Conditional)
5 (Non-Productive)
Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

1:150,000

4 0 4
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Baseline Land Capability for Forest Production in the Terrestrial Local Study Area

Date: 19 Feb 2013 | Project: 11029-514

Technical: R.Labbé | Reviewer: B.McNaughtan | Drawn: K.Andruchow

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Figure 4.3-5

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Table 4.3-7 Extent of Land Capability for Forest Ecosystems Classes in the Terrestrial Local Study Area

Land Capability for Forest Ecosystems Class	Area (ha)	Percent of Terrestrial LSA
1 and 2	0	0
3	3,305	27.3
4	3,616	30.0
5	4,117	34.1
Water, lakes, roads, existing soil disturbances	1,037	8.6
Total [1]	**12,075**	**100.0**

1. Total value might not equal the sum of the individual values, due to rounding.

Unproductive soils (Class 5) are the most dominant map units in the Terrestrial LSA. They are represented by five soil series: Birkland, aaMuskeg, Stebbing, St. Lina and aaSteepbank. These soils were rated non-productive for tree growth due to their deep organic horizons, high soil moisture content and low fertility. Conditionally productive Class 4 soil series include aaBitumount, Liza and Moose Hills, and are assessed as having limitations of low soil fertility, poor soil structure and either very high or very low moisture. The Class 3 area includes the Athabasca SMUs (ABC-1 and ABC-2), which have limitations of low fertility, acidic pH and poor structure. The LCCS classes 1 or 2 soil areas were not encountered in the Terrestrial LSA.

4.3.2 Baseline Case Vegetation

The extent of ecosite phases in the Terrestrial LSA and the Project footprint is summarized in Table 4.3-8, with reference to CMNS ecosite phases (Beckingham and Archibald 1996). Upland ecosite phases constitute 52.8% of the Terrestrial LSA. The most abundant upland ecosite phase is c1 (Labrador tea-mesic-jack pine-black spruce), which comprises 12.2% of the Terrestrial LSA. Wetland ecosite phases comprise 39.3% of the Terrestrial LSA. The most abundant wetland ecosite phase is j1 (treed poor fen), comprising 27.2% of the Terrestrial LSA.

Table 4.3-8 Ecosite Phases and Disturbances in the Footprint and the Terrestrial Local Study Area

Land Cover	Terrestrial LSA -Baseline		Project Footprint	
	Area (ha)	Proportion of Terrestrial LSA (%)	Area (ha)	Proportion of Terrestrial LSA (%)
Upland Ecosite Phases				
a1- lichen jack pine	389	3.2	35	0.3
b1- blueberry jack pine-aspen	779	6.4	51	0.4
b1- regenerant of blueberry jack pine-aspen	23	0.2	0	*<0.1*
b2- blueberry aspen (white birch)	828	6.9	73	0.6
b3- blueberry aspen-white spruce	406	3.4	47	0.4
b4- blueberry white spruce-jack pine	125	1.0	4	<0.1
c1- Labrador tea-mesic-jack pine-black spruce	1,468	12.2	144	1.2
d1- low-bush cranberry aspen	626	5.2	73	0.6
d2- low-bush cranberry aspen-white spruce	677	5.6	54	0.5
d3- low-bush cranberry white spruce	36	0.3	4	<0.1
e1- dogwood balsam poplar-aspen	15	0.1	-	-
e2- dogwood balsam poplar-white spruce	2	0.0	1	<0.1
f1- horsetail balsam poplar-aspen	1	0.0	-	-
f2- horsetail balsam poplar-white spruce	27	0.2	-	-
g1- Labrador tea- subhygric- black spruce-jack pine	954	7.9	83	0.7
h1- Labrador tea/horsetail white spruce-black spruce	2	0.0	<1	<0.1
Upland Ecosite Phases Subtotal [1]	***6,357***	***52.8***	***570***	***4.7***
Wetland Ecosite Phases				
i1- treed bog	225	1.9	21	0.2
i2- shrubby bog/ shrubby poor fen	32	0.3	-	-
j1- treed poor fen	3,286	27.2	257	2.1
j2- shrubby poor fen	149	1.2	14	0.1
k1- treed rich fen	367	3.0	23	0.2
k2- shrubby rich fen	633	5.2	31	0.3
k3- graminoid rich fen	38	0.3	1	0.0
SR – shrubby riparian	24	0.2	-	-
Wetland Ecosite Phases Subtotal [1]	***4,754***	***39.3***	***347***	***2.9***
Other (Anthropogenic)				
AIG – gravel pit	4	0.0	-	-
AIH – highway, road ROW	16	0.1	<1	<0.1
AII – industrial sites, plant sites	155	1.3	<1	<0.1
CIP – pipeline ROW	233	1.9	15	0.1
CIU – unknown clearings	8	0.1	-	-
CIW – well sites	111	0.9	9	0.1
Hf – herbaceous forbs	40	0.3	3	<0.1
Hg – herbaceous grassland	133	1.1	14	0.1
So – shrub open	171	1.4	16	0.1
Other (Anthropogenic) Subtotal [1]	***870***	***7.2***	***57***	***0.5***
Water				
NWF – flooded (i.e., beaver ponds)	0	0.0	-	-
NWL – lake, pond	88	0.7	1	<0.1
NWR – river	7	0.1	-	-
Water Subtotal	***95***	***0.8***	***1***	***0.0***
Total[1]	**12,075**	**100.0**	**975**	**8.1**

[1] Total value might not equal the sum of the individual values, due to rounding.

4.3.2.1 Rare Plants

Rare Vascular Plants

Rare plant surveys were conducted for the Project. Six rare vascular plant species and three rare non-vascular plant species were found in the Terrestrial LSA (Figure 4.3-6). Golden saxifrage (*Chrysosplenium iowense*) is ranked as an S3 species on the ACIMS tracking list (ACIMS 2012, Internet Site) and is ranked as sensitive by AESRD (ASRD 2010a). In Alberta, it is found along stream banks and marshy ground in shady areas (Moss 1983). Golden saxifrage was found at two locations in the Terrestrial LSA:

- a treed rich fen; and
- a shrubby riparian area.

Goldthread (*Coptis trifolia*) is ranked as an S3 species on the ACIMS watch list (ACIMS 2012). In Alberta, it is found in moist damp, mossy woodlands (Kershaw et al. 2001). Goldthread was found at three locations in the Terrestrial LSA:

- a transition area between a Labrador tea-mesic jack pine-black spruce forest to a rich shrubby fen;
- a Labrador tea/horsetail white spruce-black spruce forest adjacent to the Sand River; and
- an open cutline near a lichen jack pine forest.

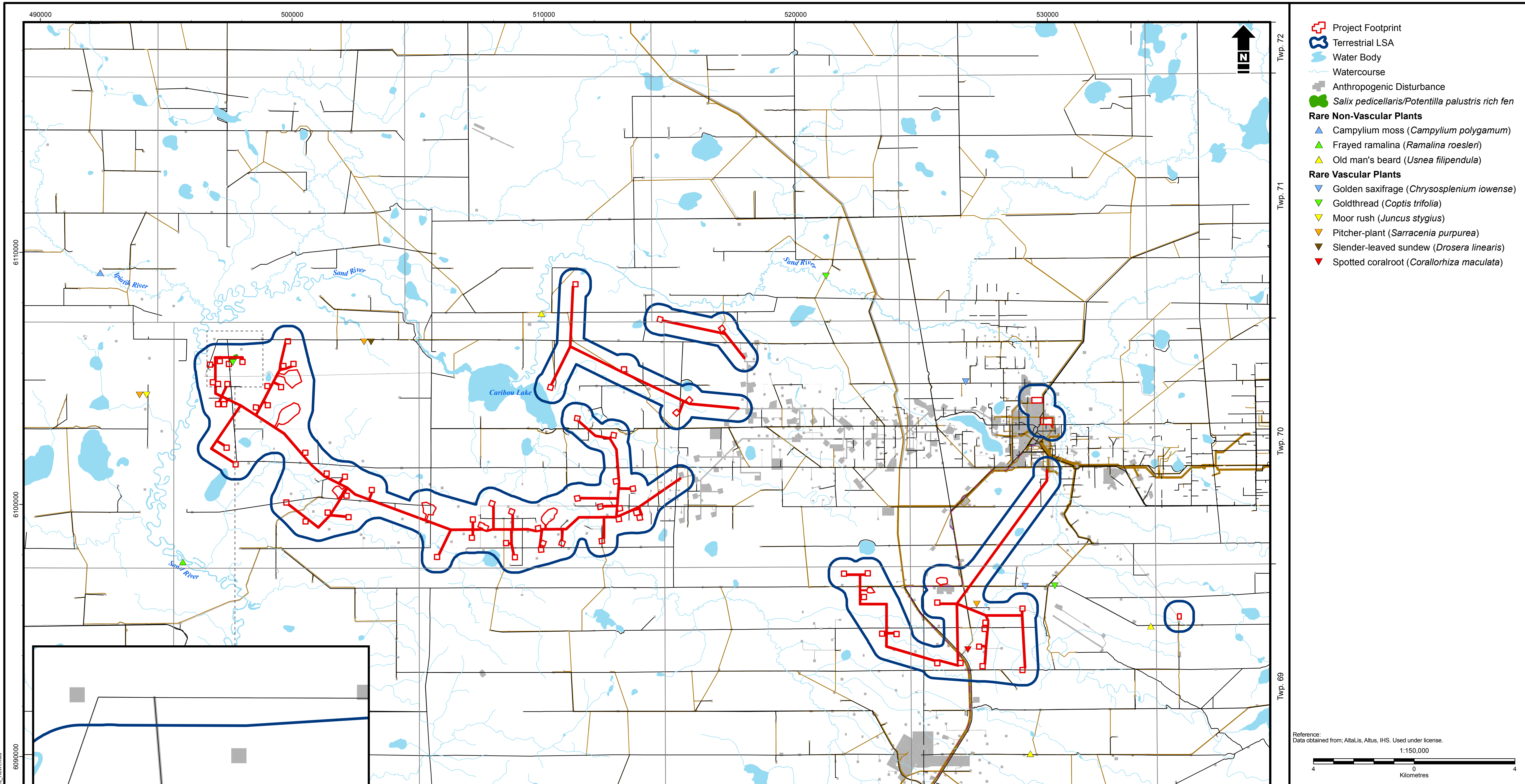
Spotted coralroot (*Corallorhiza maculata*) is an S3 species but is not on the ACIMS tracked or watch list (ACIMS 2012). However, it is ranked as Sensitive by AESRD (ASRD 2010). It is found in moist to dry forests (Johnson et al. 2009). Spotted coralroot was found at one location in the Terrestrial LSA, a low-bush cranberry aspen-white spruce forest.

Slender-leaved sundew (*Drosera linearis*) is an S3 species on the ACIMS watch list (ACIMS 2012) and is ranked as sensitive by AESRD (ASRD 2010). Slender-leaved sundew requires alkaline conditions for growth and is found in bogs and fens (Kershaw et al. 2001). Slender-leaved sundew was found at one location in the Terrestrial LSA, a rich shrubby-graminoid fen complex.

Marsh rush (*Juncus stygius var. americanus*) is an S2 species on the ACIMS tracking list (ACIMS 2012, Internet Site) and is ranked as May-Be-At-Risk by AESRD (ASRD 2010a). In Alberta, it is found in fens and in mossy areas around springs and seepages (Kershaw et al. 2001). Marsh rush was found in a rich graminoid fen in the Terrestrial LSA.

Pitcher-plant is an S3 species but is not on the ACIMS tracked or watch species list (ACIMS 2012); however, it is considered a Sensitive species by AESRD (ASRD 2010a). It is an insectivorous perennial herb found in wetlands, usually with Sphagnum mosses (Kershaw et al. 2001). Pitcher-plant was found at three locations within the Terrestrial LSA:

- a rich treed fen;
- a rich shrubby fen; and
- a rich graminoid fen.



Foster Creek Thermal Project Phase J Expansion

Rare Plants and Rare Ecological Communities Observed in the Terrestrial LSA

Date: 19 Feb 2013 | Project: 307074-00146

Technical: J.Lemire | Reviewer: M.Moss | Drawn: T.Graham

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Figure 4.3-6

Rare Non-Vascular Plants

Campylium polygamum is a moss and an S3 species listed on the ACIMS watch list (ACIMS 2012). Within the Terrestrial LSA, this moss was found at one site in an open shrubby swamp.

Frayed ramalina (*Ramalina roesleri*) is ranked as an S1 species on the ACIMS tracking list (ACIMS 2012, Internet Site). In the Terrestrial LSA, frayed ramalina was found at one site, a dogwood aspen-white spruce ecosite.

Old man's beard (*Usnea filipendula*) is an S3 species but is not on the ACIMS tracked or watch list (ACIMS 2012). However, it is listed as sensitive by ASRD (2010). Old man's beard is an epiphytic lichen species and was found at three locations within the Terrestrial LSA:

- a horsetail white spruce ecosite;
- a Labrador tea-horsetail white spruce-black spruce ecosite; and
- a poor shrubby fen.

4.3.2.2 Rare Ecological Communities

An Alberta Conservation Information Management System (ACIMS) data search (ACIMS 2012) for rare ecological community occurrences in and adjacent to the Terrestrial LSA was completed in October 2012. One rare community was identified during this search. A *Carex limosa* - *Scheuchzeria palustris* / *Sphagnum teres* - *Sphagnum subsecundum* (mud sedge - scheuchzeria/thin-leaved peat moss) ecological community was identified at 04-04-070-13 W4M on August 18, 2008, to the west of the Terrestrial LSA and will not be affected by the Project. This rare ecological community is characterized as a shrubby wetland with a dominant cover of mud sedge (*C. limosa*) and scheuchzeria (*S. palustris*) (Allen 2012, pers. comm.).

During fieldwork conducted for the Project, a rare wetland ecological community, *Salix pedicellaris/Potentilla palustris* (bog willow/marsh cinquefoil rich fen), was identified within the Terrestrial LSA (Table 4.3-9; Figure 4.3-6).

Table 4.3-9 Rare Ecological Communities in the Terrestrial Local Study Area

Rare Ecological Community	Baseline Case	
	Area (ha)	Percent of LSA
***Salix pedicellaris/Potentilla palustris* rich fen**		
k2 – shrubby rich fen	2.5	<0.1
Total	2.5	<0.1

The bog willow/marsh cinquefoil rich fen identified in the Terrestrial LSA is a component of a larger wetland complex. The indicator species of this community, which were observed, are bog willow (*S. pedicellaris*) and marsh cinquefoil (*P. palustris*), forming the dominant cover, as well as two-stamened sedge (*C. diandra*). Additionally, twenty-one vascular plant species and four non-vascular plant species were found in the community.

4.3.2.3 Non-Native and Invasive Species

Four non-native and invasive species were identified close to existing disturbances in the Terrestrial LSA (Figure 4.3-7). Two of these species are listed in the Weed Control Regulation of the Weed Control Act:

- Canada thistle (*Cirsium arvense*) is listed as a noxious species in Alberta and was found in three locations within the Terrestrial LSA; and
- nodding thistle (*Caduus nutans*) is listed as a prohibited noxious species in Alberta and was found in one location within the Terrestrial LSA.

The other two species observed are considered non-native plant species in the Rogue's Gallery of Invasive Non-native Plants of Alberta (ANPC 2012) and include:

- common dandelion (*Taraxacum officinale*) at three locations in the Terrestrial LSA; and
- alsike clover (*Trifolium hybridum*) was at one location in the Terrestrial LSA.

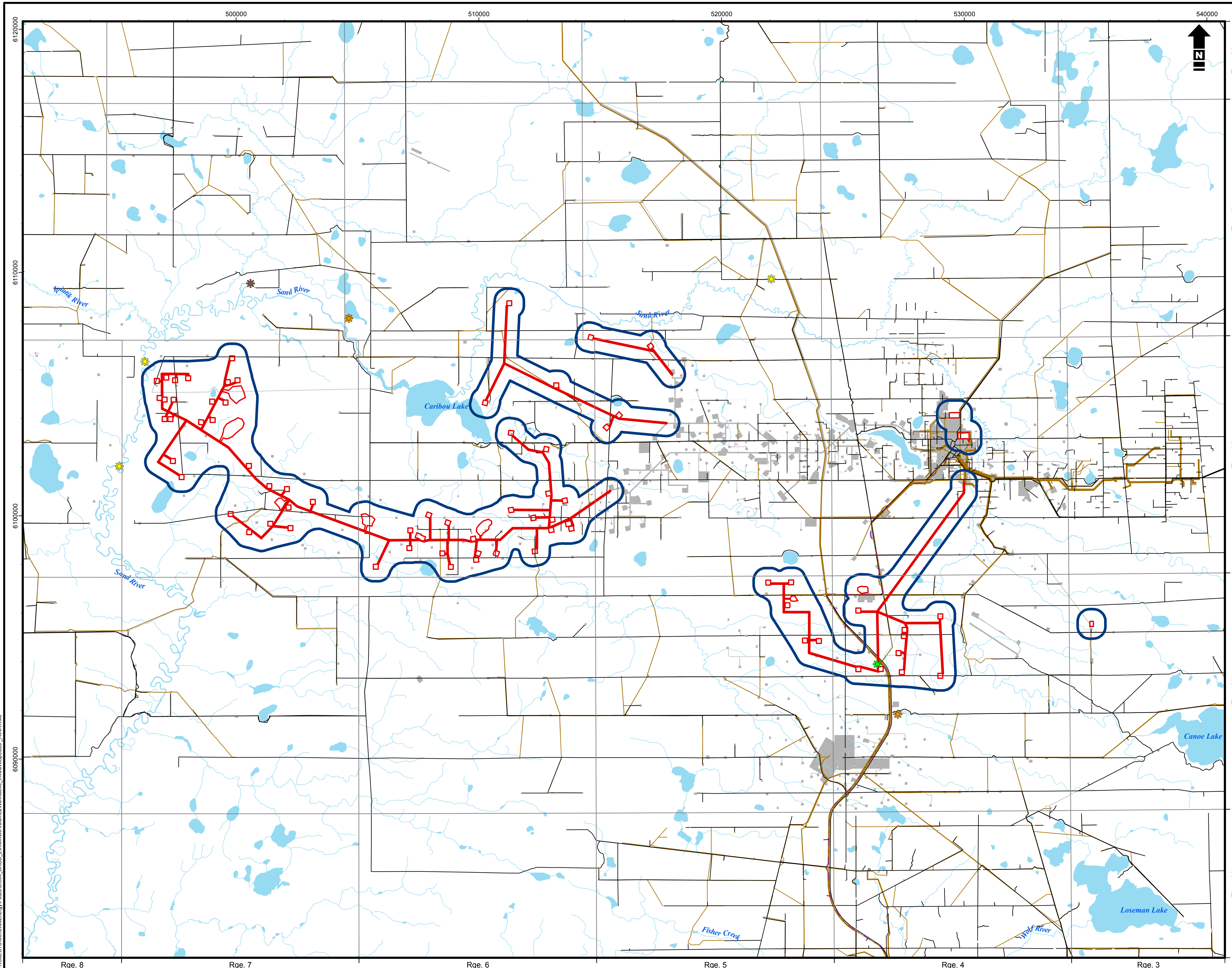
4.3.3 Productive Forests and Timber

Forest productivity, based on the Timber Productivity Rating (TPR) (Smith and D'Eon 2006), is an AVI attribute with four classes: good, moderate, fair, or unproductive. Table 4.3-10 summarizes the extent of forest productivity in the Terrestrial LSA by the TPR classes.

Table 4.3-10 Summary of Productive Forests in the Terrestrial Local Study Area

Timber Productivity Rating (TPR)	Terrestrial LSA - Baseline Case	
	Area (ha)	Proportion of Terrestrial LSA (%)
Productive Forest		
Good	3,814	31.6
Moderate	4,688	38.8
Fair	878	7.3
Total Productive	***9,380***	***77.7***
Unproductive Forest	2,391	19.8
Non-Forested, no TPR	304	2.5
Total	**12,075**	**100.0**

A total of 77.7% of the Terrestrial LSA is considered forested and productive for timber, while 19.8% is considered forested and unproductive (Table 4.3-10; Figure 4.3-8). Slightly less than one third of the productive forest (31.6%) has a TPR of "good."



- Project Footprint
- Terrestrial LSA
- Water Body
- Watercourse
- Road
- Pipeline
- Powerline
- Anthropogenic Disturbance

Non-native Invasive Species

- Alsike clover (*Trifolium hybridum*)
- Common dandelion (*Taraxacum officinale*)

Noxious and Prohibited Noxious

- Creeping thistle (*Cirsium arvense*)
- Nodding thistle (*Carduus nutans*)

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

1:150,000

4 0 4

Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Location of Non-native and Invasive Species In and Adjacent to the Terrestrial LSA

Date: 19 Feb 2013	Project: 307074-00146	
Technical: J.Lemire	Reviewer: M.Moss	Drawn: T.Graham

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Figure 4.3-7

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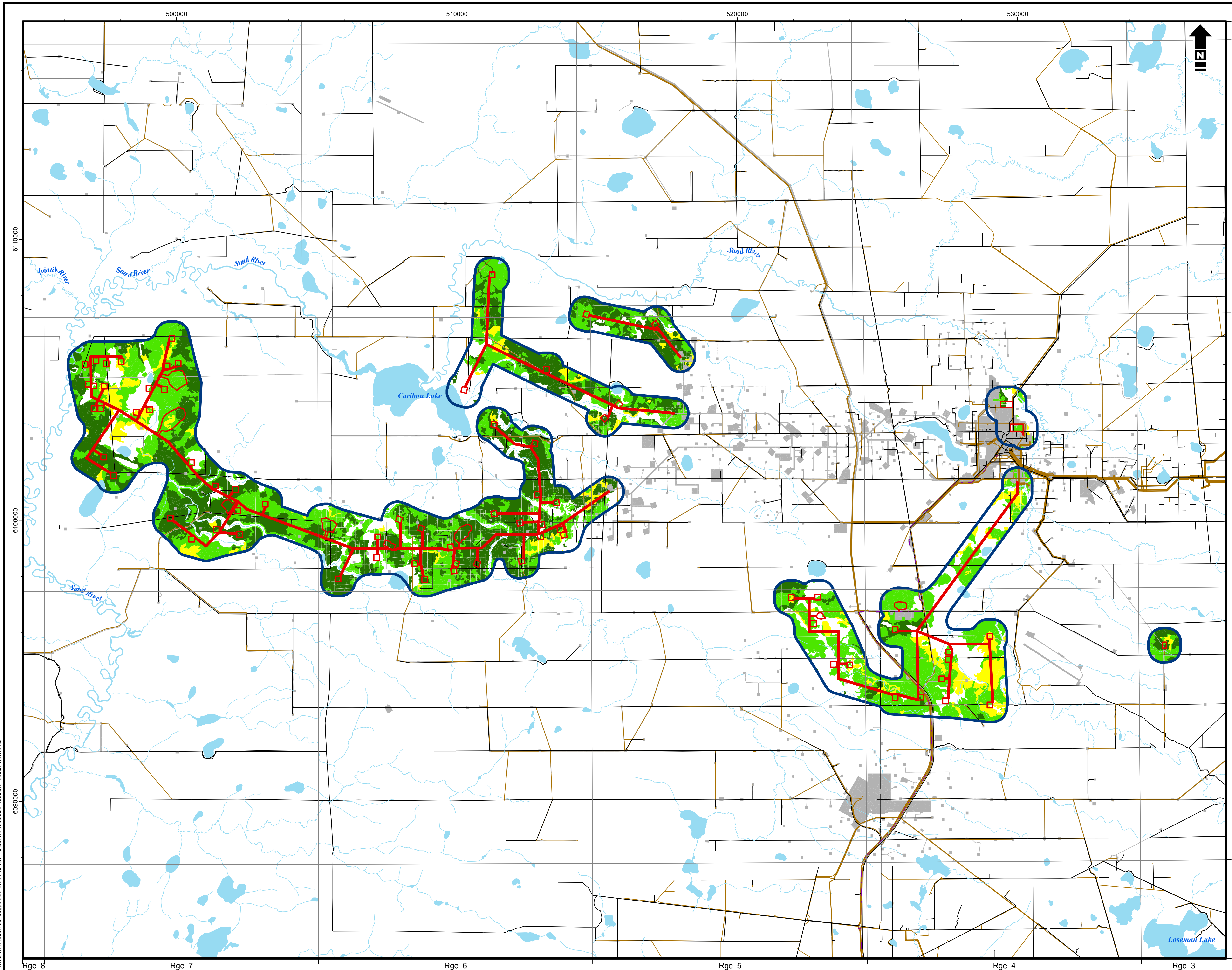

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Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline
Anthropogenic Disturbance

Timber Productivity Rating

Good
Medium
Fair

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

1:130,000

2.5 0 2.5
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Productive Forests in the Terrestrial Local Study Area

Date: 19 Feb 2013
Project: 11029-514
Technical: M.Moss
Reviewer: R.Lauzon
Drawn: T.Graham

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Figure
4.3-8

4.4 PREVIOUS DEVELOPMENT AND DISTURBANCE

4.4.1 Vegetation Disturbance

Anthropogenic vegetation disturbances account for 7.2% of the Terrestrial LSA (870 ha; Table 4.4-1). Pipeline ROWs and shrub open (So) are the most extensive disturbance types. Together these two types of disturbance account for 46.4% of all anthropogenic disturbances in the Terrestrial LSA at Baseline Case. Seismic lines, transmission lines, and pipelines (i.e., disturbance categories not including So), cover 5.7% of the Terrestrial LSA. Non-vegetated disturbances, such as gravel pits, roads, industrial facilities, and well sites, cover 2.4% of the Terrestrial LSA.

Table 4.4-1 Summary of Vegetation Disturbances in the Terrestrial Local Study Area

Land Cover	Area (ha)	Percent of LSA	Percent of All Disturbances
AIG – gravel pit	4	0.0	0.4
AIH – highway, road ROW	16	0.1	1.9
AII – industrial sites, plant sites	155	1.3	17.8
CIP – pipeline ROW	233	1.9	26.8
CIU – unknown clearings	8	0.1	0.9
CIW – well sites	111	0.9	12.8
Herbaceous forbs	40	0.3	4.6
Herbaceous grassland	133	1.1	15.2
So – shrub open	171	1.4	19.6
Total [1]	**870**	**7.2**	**100.0**
Vegetation communities (from Table 4.3-10)	11,111	92.0	n/a
Water features	95	0.8	n/a
Total [1]	**12,075**	**100.0**	**n/a**

[1] Total value might not equal the sum of the individual values, due to rounding.
n/a – not applicable.

There are approximately 57 ha of existing vegetation disturbance in the Project footprint in the Baseline Case.

4.4.2 Soil Disturbance

The Project footprint contains approximately 29 ha of existing soils disturbance, which includes industrial sites, well sites, compressor sites, roads and buried pipelines (Table 4.4-2).

Table 4.4-2 Summary of Soil Disturbances in the Terrestrial Local Study Area

Type of Baseline Case Soil Disturbance	Area (ha)	Percent of Footprint (%)	Percent of Soil Disturbances (%)
Compressor sites	0.7	<0.1	2.5
Development, Industrial Facilities, Plant Sites	0.3	<0.1	1.0
Highway and other road ROWs	19.2	2.0	65.7
Production Well Pad, Well Sites	8.1	0.8	27.7
Rights-of-way – buried pipeline	0.9	0.1	3.1
Total [1]	**29.3**	**3.0**	**100.0**

1. Total value might not equal the sum of the individual values, due to rounding.

No contamination in the Baseline Case disturbances in the Project footprint has been reported.

4.5 WILDLIFE AND WILDLIFE HABITAT

Baseline surveys for wildlife were conducted in and adjacent to the Terrestrial LSA to collect site-specific information on wildlife species. The Terrestrial LSA is delineated in Figure 4-1 and detailed information regarding study approach for wildlife and wildlife habitat is discussed in Volume 5, Section 13.

4.5.1 Amphibians

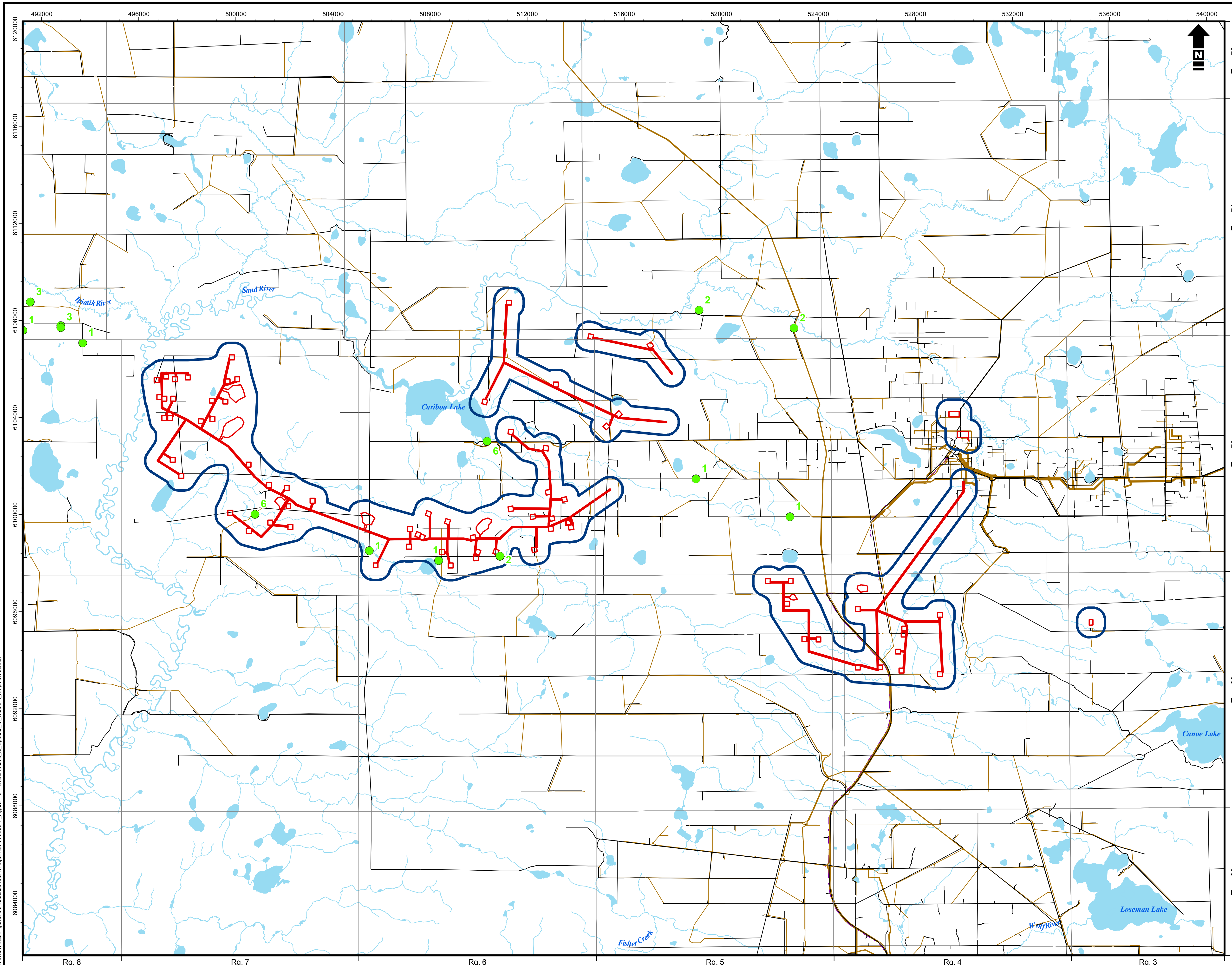
Four species of amphibians occur in the RSA including the Canadian toad, western toad, boreal chorus frog and wood frog. Two of these species, the Canadian toad and the western toad, are species of concern.

No Canadian toads were detected during amphibian surveys conducted in the Terrestrial LSA and no Canadian toads were found during any other surveys conducted for the FCTP (AEC 2001, 1999). Thirty western toads were detected in and adjacent to the LSA during the amphibian survey, and incidentally (Figure 4.5-1). Western toads were not observed during previous surveys conducted for the FCTP (AEC 2001, 1999).

Boreal chorus frogs and wood frogs are common species and both were detected in the Terrestrial LSA.

4.5.2 Reptiles

The red-sided garter snake is a provincially-listed species of concern. No red-sided garter snakes were detected during any field work conducted in and adjacent to the Terrestrial LSA for the Project or for other surveys conducted for the FCTP (AEC 2001, 1999).



Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline

Amphibians

Western Toad (30)

3 ← observation location
↑
# of individuals noted

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

1:150,000

4 0 4
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Observations of Species of Concern: Amphibians

Date: 14 Feb 2013		Project: 11029-514
Technical: C.Corbett	Reviewer: R.Lauzon	Drawn: C.Jackson

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Figure 4.5-1

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4.5.3 Birds

4.5.3.1 Waterbirds

The Terrestrial LSA is located within the Moostoos Upland a locally important habitat subregion for staging ducks, a nationally important habitat subregion for breeding colonial waterbirds and a locally important habitat subregion for staging colonial waterbirds (Poston et al. 1990). However, Poston et al. (1990) identified no important migratory bird habitat areas or wetland sites in or near the Terrestrial LSA.

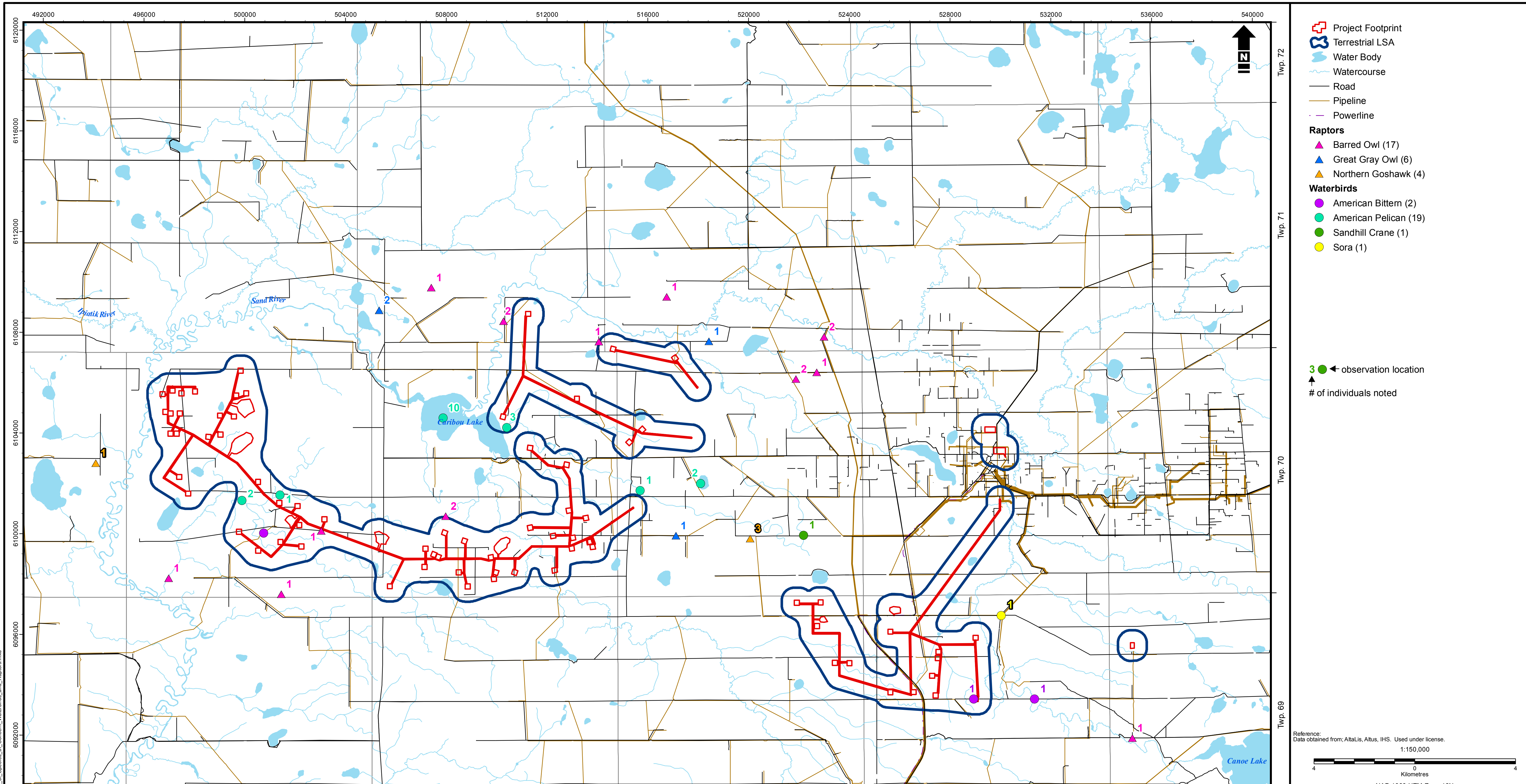
Waterbird species of concern that nest and forage within wetland habitats in the RSA include eight waterfowl species (pied-billed grebe, horned grebe, western grebe, green-winged teal, northern pintail, lesser scaup white-winged scoter and trumpeter swan), four wading birds (American bittern, great blue heron, yellow rail and sora), American white pelican and black tern. Of the waterbird species of concern, 3 American bitterns, 1 sora and 19 pelicans were observed in and adjacent to the Terrestrial LSA (Figure 4.5-2). There are no pelican nesting areas in or adjacent to the Terrestrial LSA. Pied-billed grebes, lesser scaup, white winged scoter, American bittern, sora and American bittern were observed adjacent to the Terrestrial LSA during previous surveys conducted for the FCTP (AEC 2001, 1999). No horned grebe, western grebe, trumpeter swan, or yellow rail were detected during any field work conducted in and adjacent to the Terrestrial LSA for the Project or for other surveys conducted for the FCTP (AEC 2001, 1999).

Sandhill cranes nest on the ground in lowland habitat such as bogs and fens (FAN 2007). Two sandhill cranes were detected in and adjacent to the Terrestrial LSA during the breeding bird survey (Figure 4.5-2).

4.5.3.2 Raptors

Twenty-two raptor species may occur in the RSA, with twelve of these species being identified as species of concern. Seventeen barred owls and six great gray owls were detected in the Terrestrial LSA in a mix of upland and lowland habitats during owl and breeding bird surveys and incidentally (Figure 4.5-2). Northern goshawks were observed at two locations near the Terrestrial LSA including three chicks observed in an active nest. No ground nesting raptors were observed during wildlife surveys conducted for the Project. One active short-eared owl nest was found within a treed rich fen adjacent to the Terrestrial LSA during previous field work (AEC 1999).

No osprey were detected during wildlife surveys for the Project although osprey were observed adjacent to the Terrestrial LSA during previous surveys conducted for the FCTP (AEC 1999). Bald eagles and peregrine falcons were not detected during any field work conducted for the FCTP (AEC 2001, 1999). American kestrels were observed during previous surveys conducted for the FCTP (AEC 2001, 1999).



Foster Creek Thermal Project Phase J Expansion

Observations of Species of Concern: Waterbirds and Raptors

Date: 14 Feb 2013 | Project: 11029-514

Technical: C.Corbett | Reviewer: R.Lauzon | Drawn: C.Jackson

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Figure 4.5-2

4.5.3.3 Other Birds and Songbirds

The sharp-tailed grouse, common nighthawk, black-backed woodpecker and pileated woodpecker are bird species of concern that may occur in the RSA. One common nighthawk and one pileated woodpecker were detected adjacent to the Terrestrial LSA during the breeding bird survey (Figure 4.5-3). Sharp-tailed grouse were observed in treed rich fens adjacent to the Terrestrial LSA during the amphibian survey in May 2011 and during winter tracking in 2012. Although there is suitable habitat for the black-backed woodpecker, it was not detected. The common nighthawk, black-backed woodpecker and pileated woodpecker were observed adjacent to the Terrestrial LSA during previous surveys conducted for the FCTP (AEC 2001, 1999).

Ninety-seven songbird species may occur in the RSA including 17 species of concern (Volume 5, Section 13). Four of these species (olive-sided flycatcher, bay-breasted warbler, brown creeper, common yellowthroat and western tanager) were detected in and adjacent to the Terrestrial LSA during the breeding bird surveys and incidentally (Figure 4.5-3).

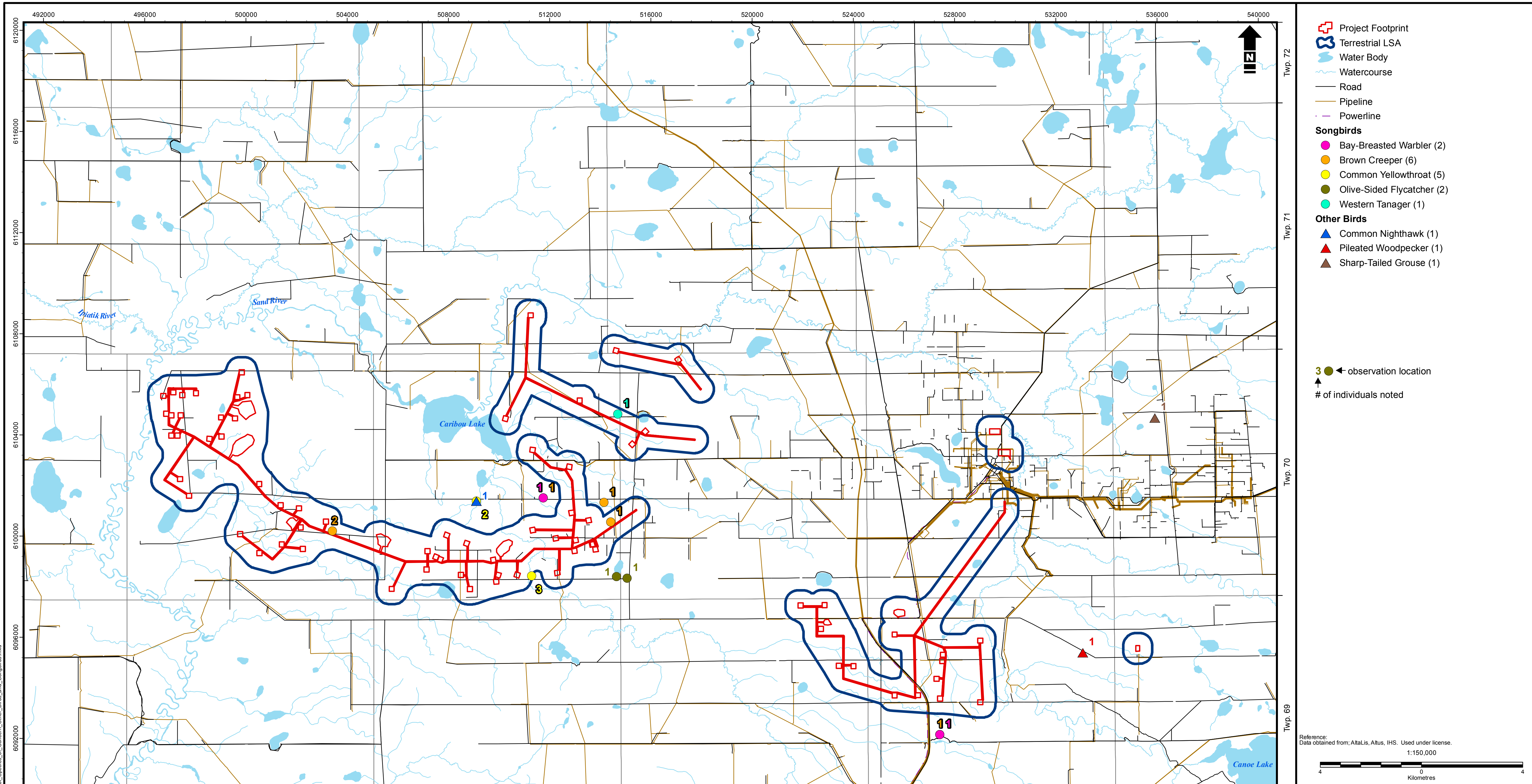
Several species of concern were detected adjacent to the Terrestrial LSA during previous surveys conducted for the FCTP (AEC 2001, 1999) including: least flycatcher, western wood-pewee, brown creepers, Cape May warbler, black-throated green warbler and Canada warbler.

4.5.4 Mammals

Forty-eight mammal species may occur in the RSA, with nine of these species identified as species of concern.

4.5.4.1 Bats

Six species of bats may occur in the RSA of which five are species of concern: little brown bat, northern bat, hoary bat, eastern red bat and silver-haired bat. Bat surveys were conducted in and adjacent to the Terrestrial LSA in 2010 and 2011 using mist nets and bat detectors. A total of 14 bats were captured within the LSA including 9 little brown bats, 3 eastern red bats, 1 silver-haired bat, and 1 hoary bat (Figure 4.5-4). Analysis of bat detector recordings, identified 11 species/species groups including *Myotis* sp., little brown bat, northern bat, eastern red bat, eastern red bat/little brown bat, hoary bat, silver-haired bat, silver-haired bat/big brown bat, hoary bat/silver-haired, hoary bat/big brown bat, and high and low frequency bats. All five bat species of concern were either detected or captured in and adjacent to the LSA.



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Data obtained from; AltaLis, Altus, IHS. Used under license.

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Foster Creek Thermal Project Phase J Expansion

Observations of Species of Concern: Other Birds and Songbirds

Date: 14 Feb 2013	Project: 11029-514
Technical: C.Corbett	Reviewer: R.Lauzon / Drawn: C.Jackson

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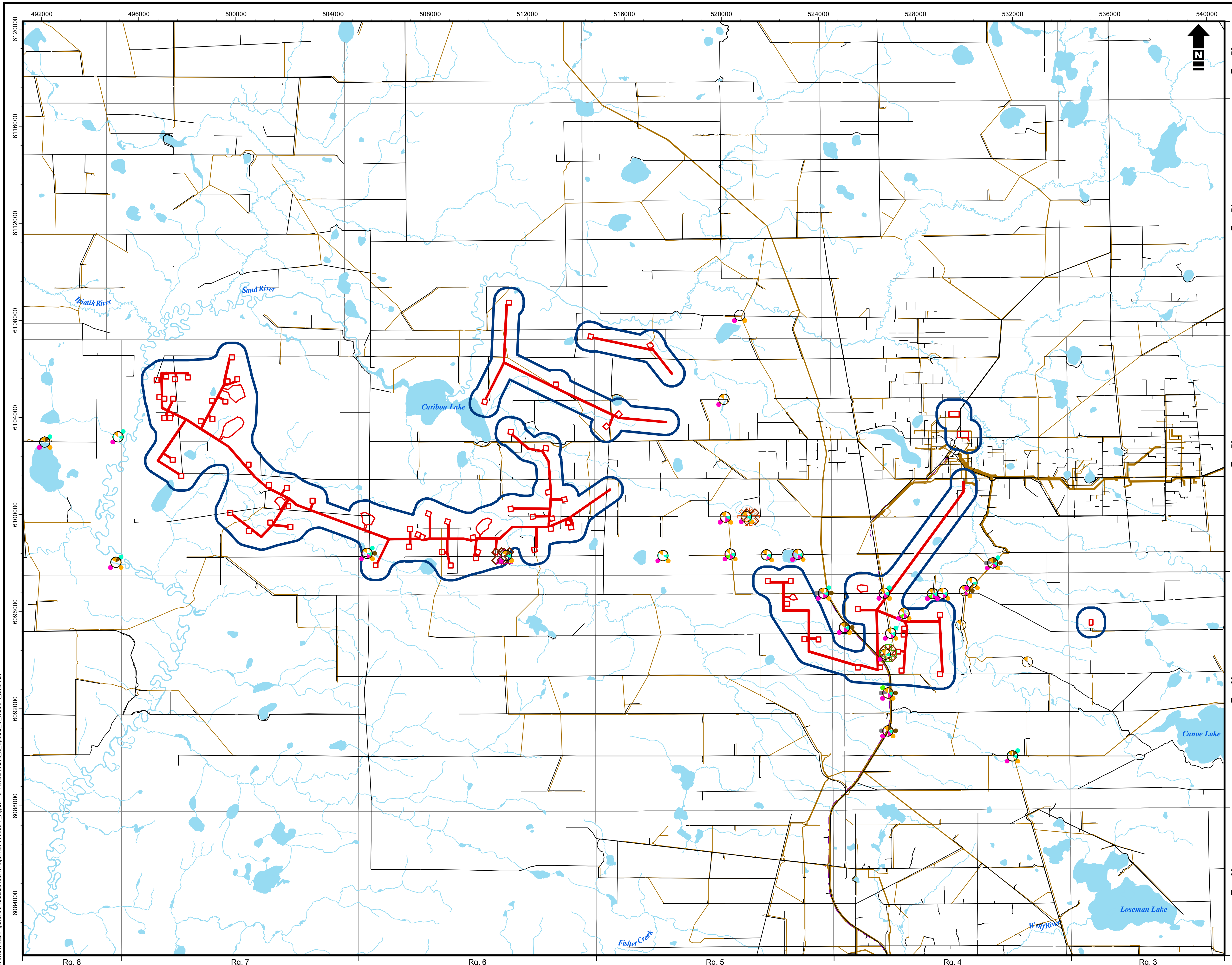
Figure 4.5-3



Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline

Bat Species Captured

- Eastern Red Bat (3)
- Hoary Bat (1)
- Little Borwn Bat (9)
- Silver-Haired Bat (1)

Bat Species Detected

- Myotis sp. (12)
- Little Brown Bat (206)
- Northern Bat (28)
- Eastern Red Bat (167)
- Eastern Red Bat / Little Brown Bat (559)
- High Frequency Bat (16)
- Hoary Bat (177)
- Silver-Haired Bat (4)
- Silver-Haired Bat / Big Brown Bat (437)
- Hoary Bat / Big Brown Bat (8)
- Hoary Bat / Silver-Haired Bat (3)
- Low Frequency Bat (59)

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

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NAD 1983 UTM Zone 12N

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Foster Creek Thermal Project Phase J Expansion

Observations of Species of Concern: Bats

Date: 14 Feb 2013	Project: 11029-514	
Technical: C.Corbett	Reviewer: R.Lauzon	Drawn: M.Darroch

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Figure 4.5-4

4.5.4.2 Small Mammals

Twenty-four small mammal species may occur in the RSA, none of which are species of concern. Red squirrels and snowshoe hares were found throughout most of the Terrestrial LSA during winter tracking and other surveys conducted for the Project. Beavers were detected in various habitats including fens, lakes and creeks throughout most of the LSA.

4.5.4.3 Carnivores

Fourteen carnivore species may occur in the RSA including four species of concern: long-tailed weasel, fisher, wolverine and Canada lynx. Carnivores detected using winter track counts or incidentally included: short-tailed weasel, least weasel, marten, fisher, otter, lynx, coyote, wolf and black bear. All species of concern were detected in or adjacent to the Terrestrial LSA except the wolverine.

One fisher was observed crossing a winter road adjacent to the terrestrial LSA near the existing CPF (Figure 4.5-5). Fisher and marten tracks are difficult to distinguish and were therefore combined during track surveys. Long-tailed weasels were not detected during any surveys conducted for the FCTP. Wolverines are rarely observed, and they were not detected in or adjacent to the LSA during field surveys and there are no records within the FWMIS database (AEC 2001, 1999; AESRD 2012a, Internet Site).

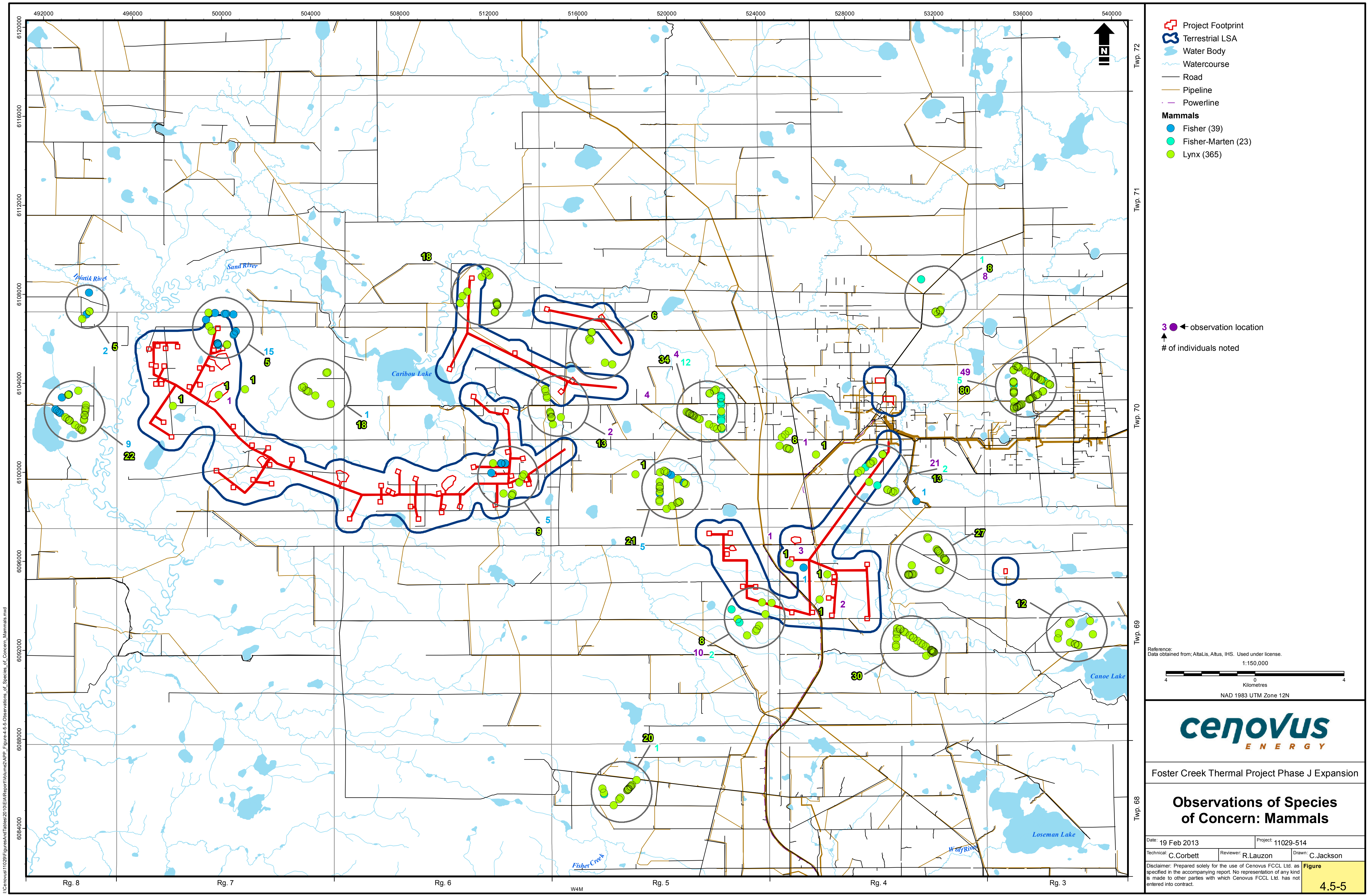
Lynx, along with snowshoe hares, were detected in almost all upland and wetland habitats during winter tracking surveys in and adjacent to the Terrestrial LSA and lynx were observed during bat and soil surveys (Figure 4.5-5). Lynx have been detected in the RSA (AEC 2001, 1999; AESRD 2012a, Internet Site; Canadian Natural 2011, 2006).

4.5.4.4 Ungulates

Ungulates were surveyed using aerial surveys and winter track counts. Four ungulate species occur within the Terrestrial LSA and RSA including mule deer, white-tailed deer, moose and woodland caribou.

Deer were the most common ungulate detected in and adjacent to the Terrestrial LSA. Moose were detected primarily in upland habitats characterized by aspen, birch and white spruce during the winter tracking survey and a mix of upland and lowland habitat during ungulate aerial surveys (Figure 4.5-6).

No caribou were observed during the ungulate aerial survey; however, four groups of caribou were observed incidentally, two of these groups were foraging along the main access road near the CPF during the owl survey (Figure 4.5-6). During the 2012 winter tracking survey, 37 individual tracks were detected on-transect and incidentally. The majority of caribou were detected in wetland habitats and many were observed near high use human features such as the main access road. Caribou have been sighted in the vicinity of the Terrestrial LSA in past aerial surveys for the FCTP (AEC 2001, 1999) and caribou sign have been noted in other areas within the CLAWR (Canadian Natural 2006 and 2000).



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Twp. 72
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Twp. 70
Twp. 69
Twp. 68
Rg. 8
Rg. 7
Rg. 6
Rg. 5
Rg. 4
Rg. 3
W4M
N
Sand River
Caribou Lake
Canoe Lake
Loseman Lake
Wolf River
Fisher Creek
Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline
Mammals
Fisher (39)
Fisher-Marten (23)
Lynx (365)
observation location
# of individuals noted
Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.
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cenovus
ENERGY
Foster Creek Thermal Project Phase J Expansion
Observations of Species of Concern: Mammals
Date: 19 Feb 2013
Project: 11029-514
Technical: C.Corbett
Reviewer: R.Lauzon
Drawn: C.Jackson
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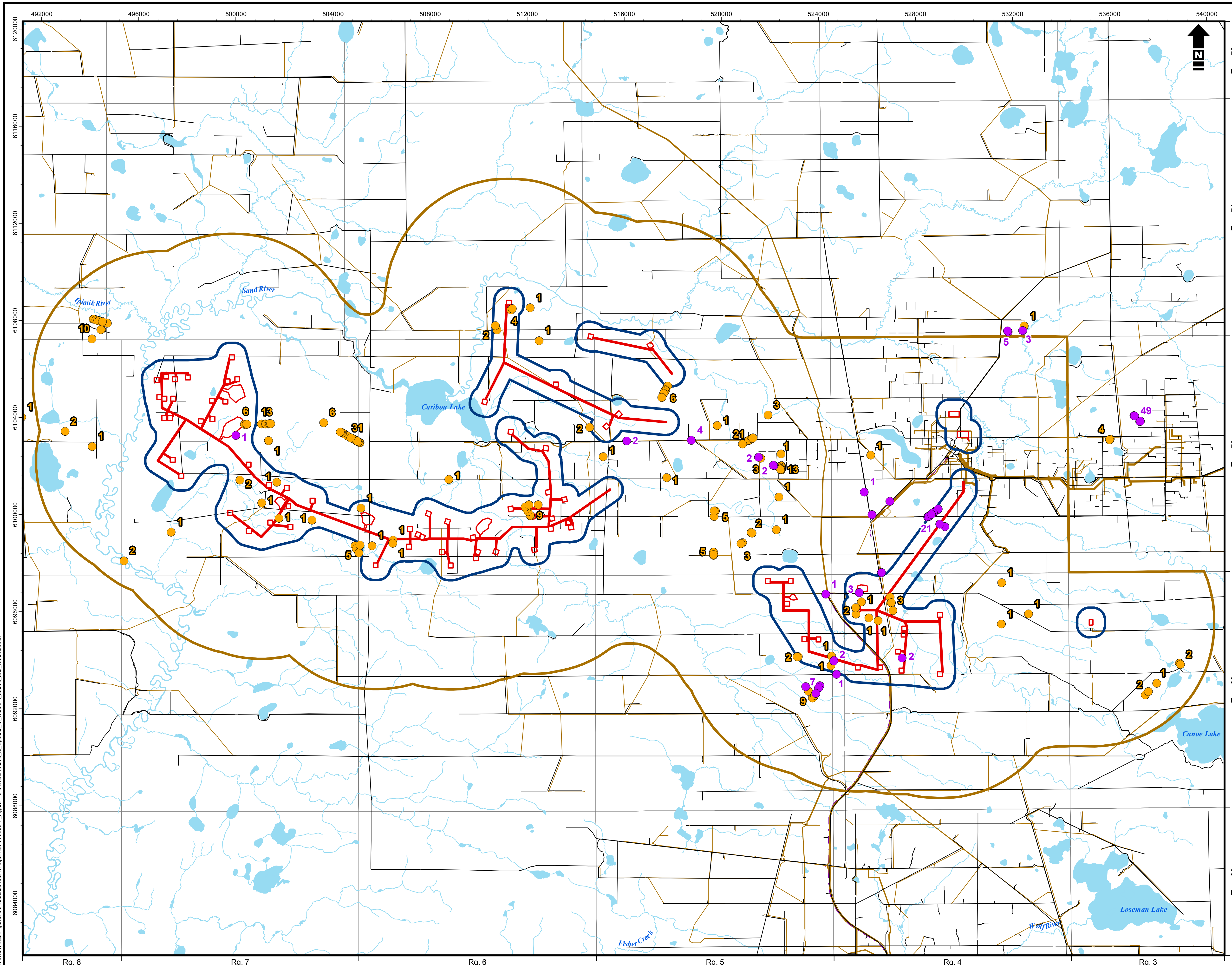
Figure
4.5-5



Project Footprint
Moose and Caribou LSA
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline

Ungulates

Caribou (106)
Moose (212)

3 ● ← observation location
↑
\# of individuals noted

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

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NAD 1983 UTM Zone 12N

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Foster Creek Thermal Project Phase J Expansion

Observations of Species of Concern: Moose and Caribou

Date: 14 Feb 2013	Project: 11029-514	
Technical: C.Corbett	Reviewer: R.Lauzon	Drawn: C.Jackson

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Figure
4.5-6

4.6 SURFACE WATER RESOURCES

Baseline surveys for the surface water resources (hydrology, surface water quality, and aquatic ecology) were conducted in and adjacent to the Surface Water Resources LSA to collect site-specific information on surface drainage patterns, water quality, sediment quality, fish community, fish habitat, and benthic macroinvertebrates. The Surface Water Resources LSA and RSA are delineated on Figures 4-1 and 4-2. Surface Water Quality sampling locations are shown on Figure 4.6-1. Detailed information regarding study approach is discussed in Volume 4, Sections 7 to 9. Named watercourses within the RSA include the Sand, Ipiatik, and Wolf rivers, along with Fisher Creek. Named water bodies within the RSA include Ipiatik, Caribou, Canoe, Touchwood, Spencer, Seibert, Pullar, Pinehurst, Wolf, and Marguerite lakes. Watercourses and water bodies within the Surface Water Resources LSA are limited to the Ipiatik River, Ipiatik Lake, Caribou Lake, Canoe Lake, and the upper portions of the Sand River. The following is a summary of hydrology, surface water quality, and aquatic ecology within the Surface Water Resources LSA and RSA.

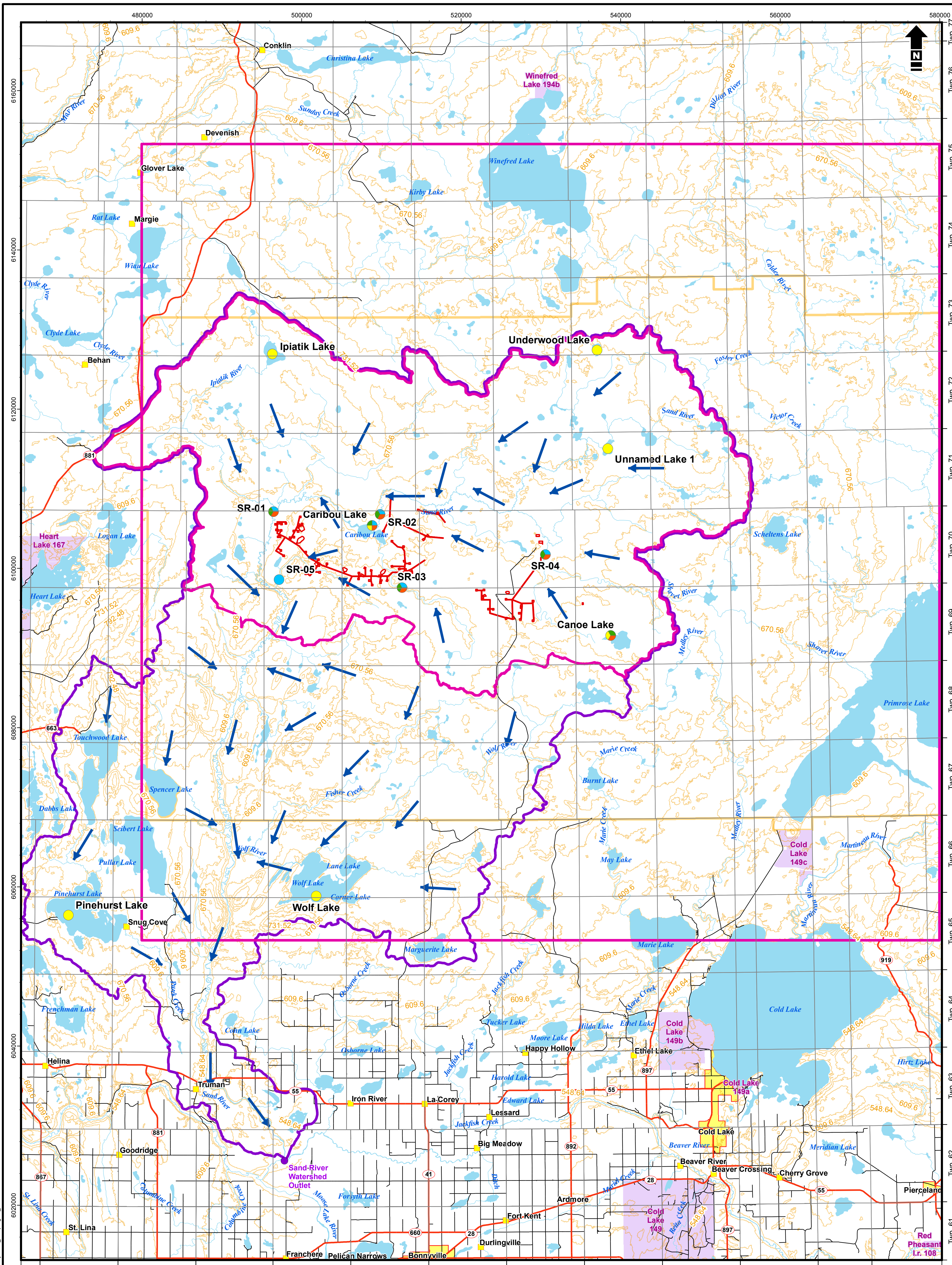
4.6.1 Hydrology

The intent of the Hydrology Assessment was to characterize the hydrology of the Sand River watershed as it relates to the Surface Water Resources LSA and RSA in terms of historical climate, stream flows, and water levels. Average hydrologic parameters for the Surface Water Resources LSA were generally estimated for the time period from 1968 to 2011. The following is a summary of the key findings for the Hydrology Baseline Case (Volume 4, Section 7):

- average air temperatures range from -17°C in winter to 16°C in summer, with an estimated mean annual precipitation of 489 mm, and an estimated annual evaporation/evapotranspiration rate of 374 mm;
- the mean annual runoff is 74 mm. The minimum and maximum open water runoff (March to October) ranges from 8.9 mm to 219.9 mm with an average of 64.2 mm. The minimum and maximum low flow runoff (November to February) ranges from 1.6 mm to 39.4 mm with an average of 9.4 mm;
- the total area of existing disturbances in the LSA is approximately 94.5 km^2 or 3.8% of the LSA, indicating a low percentage of disturbance; and
- the surface water withdrawal allocations represent 0.005% to 0.008% of the mean annual or open-water runoff from the RSA and represent a negligible portion of the runoff from the RSA.

4.6.2 Surface Water Quality

The intention of the Surface Water Quality Assessment was to characterize water quality parameters for the Sand River watershed as it relates to the Surface Water Resources LSA and RSA. Surface Water Quality Sampling locations are illustrated on Figure 4.6-1. The parameters assessed are those typically used as indicators of water quality to monitor oil sands operations in the region. The following is a summary of the key findings for the Surface Water Quality Baseline Case (Volume 4, Section 8, Surface Water Quality).



- Project Footprint
- Surface Water Resources LSA
- Surface Water Resources RSA
- Acid Sensitivity Area (ASA) - Air Emissions LSA
- Community
- Cold Lake Air Weapons Range
- Indian Reserve
- Water Body
- Watercourse
- Highway
- Road
- Surfacewater Flow Direction
- Topography Contour (interval = 100 ft)

Sampling Station

- Hydrology
- Detailed Water Quality
- Acid Sensitivity
- Sediment Quality

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Kilometres

NAD 1983 UTM Zone 12N

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license. CanVec topography data, © Department of Natural Resources Canada. All rights reserved.

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Foster Creek Thermal Project Phase J Expansion

Surface Water Quality Study Areas and Sampling Points

Date: 19 Feb 2013	Project: 307074-00142	Technical: F.Forrest	Reviewer: R. McAlpine	Drawn: S.Chin

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Figure 4.6-1

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The Sand River is a slightly alkaline watercourse with pH values ranging from 7.8 to 8.1 seasonally in 2010 and 2011. Total alkalinity varied but remained above the recommended minimum concentration (greater than 20 mg/L) throughout all seasons. Electrical conductivity and total dissolved solids (TDS) concentrations in the Surface Water Resources LSA and RSA were highest in the winter, indicating greater groundwater influences and the lack of dilution from surface runoff under the ice.

Depending on the season and location, the Sand River is considered a mesotrophic system (0.025-0.075 mg/L) as indicated by total phosphorus (TP) concentrations (CCME 2003). For the assessed unnamed tributaries to the Sand River, approximately 57.0% of the TP and 37.0% of the total nitrogen (TN) values were above the applicable provincial and federal regulatory guidelines (e.g., AENV 1999; CCME 2011a) in the Surface Water Resources LSA. Elevated TP and TN concentrations were also present in the Surface Water Resources RSA and are considered natural in origin.

Phenol concentrations exceeded the Canadian Council of Ministers of the Environment (CCME 2011a) guideline in the Surface Water Resources LSA for approximately 40% of the samples collected in the field. Elevated phenol concentrations were also present in the Surface Water Resources RSA, particularly for the Sand River. These exceedances are likely related to the organic soils naturally occurring in the Sand River watershed.

Several metal concentrations, including those for aluminum, total and dissolved iron, lead, dissolved selenium, mercury and zinc, exceeded the associated aquatic health guideline (AENV 1999; AESRD 2012, Internet Site; AEC 2001, 1999) in the LSA. These metals also exceeded the same regulatory guidelines in the RSA. Other metals that also exceeded regulatory guidelines in the Surface Water Resources RSA included cadmium, chromium and copper. Iron concentrations frequently exceeded the guideline level (0.3 mg/L) in the Surface Water Resources LSA and reached concentrations as high as 3.17 mg/L. Iron concentrations were also high (max of 3.01 mg/L) and frequently exceeded the aquatic health regulatory guideline in the Surface Water Resources RSA. However these reported exceedances can likely be attributed to natural conditions related to regional surficial geology and organic soils.

The concentrations of polyaromatic hydrocarbons (PAHs) were generally within detection limits in samples from the Surface Water Resources LSA watercourse sites, with the exception of acenaphthene (in 7% of samples), phenanthrene (in 7% of samples) and naphthalene (in 27% of samples). However, phenanthrene and naphthalene concentrations were within (less than 0.1%) regulatory guidelines. Naphthenic acids were detected at three watercourse sites in the Surface Water Resources LSA, but at concentrations less than 0.5 mg/L.

The assessed water bodies (i.e., Caribou and Canoe lakes) within the Surface Water Resources LSA are characterized as shallow and well mixed based on temperature and oxygen profiles from 2011. These lakes were less than 5 m deep and not stratified during the fall sampling programs with relatively consistent temperature and oxygen levels throughout the water column. Nutrient and chlorophyll a concentrations suggest Caribou and Canoe lakes are moderately productive systems. The concentrations of TP ranged from 0.028 mg/L in the winter to 0.072 mg/L in the spring, which is indicative of mesotrophic to eutrophic conditions. Fluoride, TP, TN, total and dissolved iron, copper and phenol concentrations exceeded regulatory guidelines in the Surface Water Resources LSA and RSA. Metals also exceeding regulatory guidelines in the Surface Water Resources RSA include cadmium, lead and zinc. BTEX (benzene, toluene, ethylbenzene, xylene), petroleum hydrocarbons fraction (PHC), glycols, volatile organic compounds (VOCs) and PAH concentrations were within detection limits in the Surface Water Resources LSA.

Alkalinity concentrations indicate that most water bodies in the Surface Water Resources LSA and RSA are well buffered and are not considered sensitive to acidification. Five lakes within the Surface Water Resources LSA have least risk to acidification and one lake, Underwood Lake, has a low risk to acidification based on alkalinity values. Regionally, most lakes were considered as well buffered. Unnamed Lake 3, 5 and 7 has a low risk to acidification and Unnamed Lake 13 to the north of the Surface Water Resources LSA has a moderate risk to acidification based on alkalinity values. Calculated PAIs in the Baseline Case were below the corresponding critical loads (CLs) for all of the above water bodies predicting a low risk for acidification. PAIs were also below previously calculated CLs for other regionally assessed lakes, which also suggested a low risk for acidification.

Baseline Case sediment quality data for the Surface Water Resources LSA indicated that metal concentrations were low, with no metals exceeding interim freshwater sediment quality guidelines (ISQG). All PAHs measured in the Surface Water Resources LSA were below detection limits, with the exception of naphthalene at two sites (SR-02 and SR-04). The PHC F3 hydrocarbons were detected at all four watercourse sites, and PHC F4 hydrocarbons were detected at three of four (SR-02, SR-03 and SR-04) watercourse sites. The presence of naphthalene, PHC F3 and PHC F4 in the sediments are likely a natural occurrence related to Organic soils in the Sand River watershed.

4.6.3 Aquatic Ecology

The Aquatic Ecology Assessment included a review of available historical information to compile a summary of the fish habitat, fish community, and benthic macroinvertebrate communities. The historical information review was supported by field sampling programs conducted between 2010 and 2012. The sampling locations within the Surface Water Resources LSA included 18 watercourses (the Sand River, and 17 unnamed tributaries to the Sand River), as well as Caribou and Canoe lakes. The following is a summary of the key findings for the Aquatic Ecology Baseline Case (Volume 4, Section 9, Aquatic Ecology).

For the Sand River watershed, the fish community is reported to consist of 16 species of fish; however, for the Project, three representative indicator species were chosen to focus the assessment (northern pike, white sucker, and lake chub). Only sucker species and northern pike were observed in the Sand River during the field sampling. From a habitat perspective, the Sand River provides low to moderate habitat suitability for most life stages for the representative indicator fish species.

Based on field reconnaissance, 9 of the 17 unnamed tributaries to the Sand River were classified as non-defined channels. The remaining were classified as perennial watercourses with similar habitat characteristics; stable streambanks (riparian vegetation comprised of grasses and shrubs), predominately run-type habitat, substrate dominated by fines and submerged aquatic vegetation throughout the assessed reaches. Beaver activity is common throughout the Surface Water Resources LSA, which influences the channel morphology in a number of the assessed sites. The fish species captured in the unnamed tributary to the Sand River surveys were limited to sucker and minnow species.

For Caribou Lake and Canoe Lake, the available fish habitat provides moderate to good habitat suitability for the life stages associated with the representative fish species. Adult sucker and northern pike were the primary fish species captured in both lakes.

4.7 GOVERNMENT REGIONAL INITIATIVES

Cenovus participates in government approved initiatives to address industry issues and re-visits its participation in such initiatives on an ongoing basis. A full list of initiatives relating to the Project is presented in Section 3.1. Regional initiatives which have come into effect during the last operating period, or have new environmental terms and conditions, that relate to the Project are described in Sections 4.7.1 and 4.7.2.

4.7.1 Land-use Framework, Lower Athabasca Regional Plan

As part of the Land-use Framework, the Government of Alberta is currently developing regional plans which "*will identify and set resource and environmental management outcomes for air, land, water and biodiversity, and guide future decisions while considering social and economic impacts*" (Government of Alberta 2012a). The FCTP is within the Lower Athabasca Regional Plan (LARP) which came in to effect September 2012.

The LARP outlines a long-term vision for the Lower Athabasca through setting desired economic, environmental and social outcomes and objectives for the region. Strategies, actions, approaches and tools required to achieve the desired outcomes and objectives are further outlined. The plan is intended to balance regional economic development opportunities and social and environmental considerations through implementing a cumulative effects management approach.

Development of the oil sands is in keeping with the principles of the LARP which states "*the economic potential of the oil sands is optimized*" as one of its Regional Outcomes (Government of Alberta 2012a). Cenovus is actively engaged in ensuring consistency with the LARP as it relates to FCTP development.

4.7.1.1 Air Quality Management Framework for the Lower Athabasca Region

As part of LARP, the *Lower Athabasca Region Air Quality Management Framework* (Government of Alberta 2012b) was developed by AESRD to manage cumulative effects within the Region. The *Air Quality Management Framework* includes setting ambient air quality triggers and limits for NO_2 and SO_2 with guidance for long-term decision making and management (Table 4.7-1). Cenovus will work within the management frameworks and with regulators to define an appropriate point of compliance. The ambient air quality limits are determined by the annual AAAQOs. The Project's maximum predictions for Application Case ground-level SO_2, NO_2 and $PM_{2.5}$ concentrations in the LSA are below their respective AAAQOs (Section 4.2.1; Volume 3, Section 2). Maximum SO_2 and NO_2 predictions in the RSA are similarly below their respective AAAQOs. Maximum $PM_{2.5}$ concentrations are predicted to exceed the AAAQO in several communities in the RSA; however, the high concentrations are attributable to community vehicle traffic and heating emissions and the Project's contribution is negligible.

Table 4.7-1 Air Quality Management Framework for the Lower Athabasca Region

Level	Description	Management Intent
4	Ambient air quality exceeding air quality limits	Improve ambient air quality to below limits
	LIMIT	
3	Ambient air quality below but approaching air quality limits	Proactively maintain air quality below limits
	TRIGGER	
2	Ambient air quality below air quality limits	Improve knowledge and understanding, and plan
	TRIGGER	
1	Ambient air quality well below air quality limits	Apply standard regulatory and non-regulatory approaches

Source: Government of Alberta 2012b.

4.7.1.2 Surface Water Quality Management Framework for the Lower Athabasca Region

The *Lower Athabasca Region Surface Water Quality Management Framework* (Government of Alberta 2012c) was developed by AESRD to manage cumulative effects within the Region. This framework builds on, but does not replace, existing provincial legislation and policy on water quality, wastewater and the aquatic environment (Government of Alberta 2012). The goals of the Surface Water Quality Management Framework include:

- identify ambient surface water quality triggers (WQTs) and ambient surface water quality limits (WQLs) to protect surface water quality, clarify Government of Alberta expectations, address cumulative effects, and support pollution prevention and proactive management strategies; and
- enhance transparency and assurance through regular monitoring, evaluation and reporting on ambient surface water quality conditions within the lower Athabasca River from downstream of the Grand Rapids to the Athabasca River Delta.

Surface water quality management is one of the key concepts and principles that form the foundation for the overall lower Athabasca region. As indicated by the second bullet, new activities and pressures on the lower Athabasca River will be monitored and evaluated relative to a more conservative benchmark that before, namely historical conditions. The LARP (Government of Alberta 2012a) states that this does not mean that departures from historical water quality conditions will not be allowed, but rather that the cumulative environmental risks of future departures need to be comprehensively assessed and mitigated before they will be allowed. In addition, pollution prevention and continuous improvement as outlines in the AESRD's *Industrial Release Limits Policy* (AENV 2000) will remain key management principles, although departures from historical water quality conditions may be allowed.

For the Project, the surface water quality monitoring program will be coordinated with pertinent hydrogeology and hydrology monitoring programs to ensure that the suite of data will support the overall surface water management plan. A final surface water monitoring program, based on Project EPEA approval conditions, will be developed in consultation with regulatory agencies (e.g., AESRD) to ensure consistency with the concepts and principles outlined in the LARP Surface Water Quality Management Framework.

4.7.1.3 Groundwater Management Framework for the Lower Athabasca Region

As part of LARP, the *Lower Athabasca Region Groundwater Management Framework* (Government of Alberta 2012d) was developed by AESRD to manage cumulative effects within the Region. The objectives of the *Groundwater Management Framework* relate to groundwater quality and quantity. For example:

- groundwater quality is protected from contamination by maintaining conditions within the range of natural variability and not exceeding established limits; and
- groundwater resources continue to support human and ecosystem needs, and the integrity of the regional flow system is maintained (Government of Alberta 2012d).

Cenovus will work within the management framework and with regulators to develop a Groundwater Response Plan for the FCTP. The response plan will establish a logical sequence of activities that will be undertaken if a water quality or quantity trigger is exceeded during routine monitoring activities. Aspects of the plan would include:

- verifying analytical results,
- conducting confirmatory re-sampling,
- assessing the results against the natural variations,
- investigating the extent of the effect, and
- initiating a groundwater response plan that may include remediation activities.

The Groundwater Response Plan will be submitted to AESRD for Approval as part of the overall Groundwater Monitoring Program.

4.7.2 Canada's Oil Sands Innovation Alliance

Formed in March of 2012, Canada's Oil Sands Innovation Alliance (COSIA) consists of a consortium of Canadian oil sands producers focused on accelerating the pace of improving environmental performance in the oil sands region. The commitments put forward in the charter focus on collaboration and transparent exchange by vetting environmental performance goals and reporting publicly on progress towards those goals.

The guiding principle for COSIA is that members' collaboration on environmental innovation will assist in achieving COSIA goals. Four environmental priority areas that will allow COSIA to achieve these objectives are tailings, water, land and greenhouse gases. Cenovus is one of 12 founding members of COSIA, and is an active member and financial supporter of the alliance.

5 AMENDMENTS TO DESIGN AND OPERATION

5.1 PROCESS OVERVIEW

5.1.1 Design Capacity Changes

Cenovus is proposing to modify the FCTP CPF to increase the design bitumen capacity from 38,168 Sm³/sd (240,069 bbl/sd) to 46,825 Sm³/sd (294, 520 bbl/sd). This increase to the design capacity will be achieved through the optimization and expansion of the Phase FGH facilities, and is referred to as Phase J. The Project provides an incremental bitumen production of 8,657 Sm³/sd (54,451 bbl/sd). Table 5.1-1 summarizes the design stream day flow rates for the Phase A-E 2012 Optimization, Phase FGH, Phase FGH and J, and the total cumulative flow rates proposed.

Table 5.1-1 Foster Creek Thermal Project Expansion Phase Design Flow Rates

Parameter	Phase A-E 2012 Optimization Design Basis (1)	Phase FGH Design Basis	Phase FGH+J Design Basis	Total 1A-J
Dry Steam Rate (m³/sd CWE)	43,200	31,820	50,314	93,514
Total Bitumen Production (Sm³/sd)	22,258	15,910	24,567	46,825
Total Produced Water (Sm³/sd)	48,944	33,411	60,234	109,178
Produced Gas from Wells (Sm³/sd dry basis)	556,450	397,750	614,175	1,170,625
Brackish Water Consumption (Sm³/sd)	8,800	8,302	0	8,800
Total Disposal (Sm³/sd)	14,636	8,442	9,643	24,279
Overall Dry SOR	1.94	2.0	2.05	N/A
Overall PWSR	1.13	1.05	1.2	N/A
Overall Gas to Oil Ratio (GOR)	25	25	25	N/A

1. The Phase 1A-E Facility Optimization Application (2012) is pending regulatory approval (ERCB Application No. 1740407)

5.1.2 Process Changes

The Operation of the Project CPF is similar to the existing and approved FCTP Phase A-H facilities and involves the following basic unit operations:

- Steam is generated in the once through steam generators (OTSGs) and cogen Heat Recovery Steam Generator (HRSG) for use in the SAGD well pairs.
- Bitumen emulsion from the well pairs is separated into produced water, gas and bitumen.
- Bitumen is further treated to meet pipeline specifications for viscosity, density and basic sediments and water (BS&W) content.
- Produced water is de-oiled and treated for use as boiler feed water (BFW) in the OTSGs and HRSG.

- Produced gas is treated to remove sulphur compounds and used for fuel in the OTSGs and HRSG.

The Project involves an optimization and expansion of the approved Phase FGH facilities. Through the completion of optimization studies, spare capacity has been identified in the following Phase FGH process areas:

- Oil Treating (Area 03);
- Deoiling (Area 07); and
- Produced Water Treatment (Area 08).

Given that Phase FGH is forecasted to have spare water treatment capacity in the Deoiling (Area 07) and Produced Water Treatment (Area 08) areas, Cenovus plans to increase the oil treatment and steam generation capacities to increase bitumen production. Process trains to be added as part of the Project include one Steam Generation train (Area 02), one Cogeneration train (Area 12), and one Oil Treating train (Area 03). With the proposed modifications, the Project CPF will contain the following process trains:

- four Steam Generation trains (Area 02);
- four Oil Treating trains (Area 03);
- one Cogeneration train (Area 12);
- three full Deoiling trains (Area 07);
- one partial Deoiling train that includes a Skim Tank and ISFs only (Area 07); and
- three Produced Water Treatment trains (Area 08).

Major equipment to be added as part of the Project includes the following:

- one Inlet Degasser (FC3-V-0310B), installed in the Phase J footprint;
- one FWKO Drum (FC3-V-0301D), installed in the Phase J footprint;
- two Treaters (FC3-V-0302G/H), installed in the Phase J footprint;
- six OTSGs (FC3-B-0213 to 0218), installed in the Phase J footprint;
- one HRSG (FC3-B-1204), installed in the Phase J footprint;
- one Gas Turbine (FC3-GT-1202), installed in the Phase J footprint;
- one Gas Turbine Generator (FC3-G-1202), installed in the Phase J footprint;
- three Glycol Heaters with Cooling Packages, installed in the Phase J footprint;
- two Air Compressor Package(s), installed in the Phase F footprint; and
- various tanks, heat exchangers, and pumps, installed in the Phase FGH and J footprint.

All CPF equipment will be added within and adjacent to the Phase FGH CPF footprint at Section 21 and 22 Township 70 Range 4 W4M. The Project equipment will tie into common utilities, tankage, and piping headers planned for Phase FGH. Natural gas supply and sales oil shipments will occur from Phase FGH pipeline facilities.

The processing facilities are further described in Volume 1, Section 6 (Facilities). The Project process flow diagrams are provided in Volume 1 Appendix E and the material and energy balances are provided in Volume 1 Appendix F.

5.2 CONTRIBUTING PROCESS STREAMS

The Process flow diagrams for normal operating conditions are provided in Volume 1 Appendix E. Waste streams for the Project are described below and details regarding wastewater and runoff and air emission streams are discussed in Sections 5.7 and 5.8.

Waste will be generated during all stages of the Project. Both the quantities and types of waste will vary during pre-construction, construction, operations, decommissioning and reclamation. Cenovus will endeavour to minimize the potential for facility upsets which may result in a short term change to waste stream volumes. All waste will be classified as hazardous or non-hazardous based on the source of generation and its specific waste characteristics.

The estimated quantity of each anticipated waste type for the Project is based on the in situ extraction processes used, the number of occupants/employees at the site, and available data from existing SAGD operations. Engineering and waste management decisions made will influence the amount and type of waste generated. The waste quantities in Table 5.2-1 are estimates based on the 2011 FCTP waste totals, and show the incremental annual increase due to the Project, as well as the projected annual volume for all phases of FCTP. Waste streams and volumes for the Project will be tracked on an on-going basis as the Project is developed.

Table 5.2-1 Anticipated Waste Types and Expected Quantities

Waste Type	Waste Characterization	Source of Introduction	Incremental Annual Volume (Phase J)	Projected Annual Volume (Phases A to J)	Storage Method and Location(s)	Disposal Method and Location(s)
Liquid						
Acid Solutions	Corrosive Liquid, Hazardous.	Consumed during ion-exchange regenerant cycles.	<1 m^3	2 m^3	Store in corrosion resistant (plastic or lined) container on barrel dock. Store in separate area from caustics.	Spent acid solutions are neutralized and routed to a disposal well as regenerant waste. Unused Acid solutions are sent to an ERCB approved oilfield waste processing facility for neutralization to disposal well.
Caustic	Corrosive Liquid, Hazardous.	Consumed during ion-exchange regenerant cycles.	6 m^3	19 m^3	Store in corrosion resistant container in a cool, dry, well ventilated area. Store in separate area from acids and reactive metals.	Spent caustic solutions are neutralized and routed to a disposal well as regenerant waste. Unused caustic solutions are sent to an ERCB approved oilfield waste processing facility for neutralization to disposal well.
Boiler Blowdown Water	Non-Hazardous (typically, but dependant on analysis of contaminants).	Blowdown from Steam Generators.	NE	NE	To blow down tank – produced water.	Recycled in plant process and deep well disposal.
Corrosion Inhibitor/Oxygen Scavenger Solutions	Corrosion Inhibitor: Flammable, Toxic, Hazardous. Oxygen Scavenger: Corrosive, Hazardous.	Injected to process streams during normal operation.	2 m^3	11 m^3	Store in closed tanks or drums. Provide secondary containment.	Send to Class 1a or Class 1b disposal well. If unspent and uncontaminated, return to supplier.
Steam Condensate	Non-Hazardous (typically, but dependant on analysis of contaminants).	From Piping Steam Traps.	NE	NE	From slip to blow down tank to process water disposal.	From process water. Disposal through disposal pumps to disposal wells.
Water Treatment Wastewater	Non-Hazardous (typically, but dependant on analysis of contaminants).	From treatment of Produced Water.	NE	NE	Stored in produced water tank.	From produced water tank through disposal pumps deep well disposal.

Table 5.2-1 Anticipated Waste Types and Expected Quantities (continued)

Waste Type	Waste Characterization	Source of Introduction	Incremental Annual Volume (Phase J)	Projected Annual Volume (Phases A to J)	Storage Method and Location(s)	Disposal Method and Location(s)
Produced Water	Non-Hazardous (typically, but dependant on analysis of contaminants).	From Phase Separator Vessels and/or Knock-Out Drums	34 m^3	182 m^3	To oil water separator tank.	From oil water separator tank to produced water tank and disposal.
Vent/Flare Liquids	Non-Hazardous (typically, but dependant on analysis of contaminants).	From Phase Separator Vessels and/or Knock-Out Drums.	NE	NE	Pumped to oil water separator tank – produced water tank.	From produced water tank to disposal system.
Filter Backwash	Non-Hazardous (typically, but dependant on analysis of contaminants).	Filter Backwash.	NE	NE	To produced water tank or ERCB approved lined ponds.	Recycle through FCTP process. Send to an ERCB approved Class 1a or Class 1b disposal well.
Sanitary Sewage Sludge	Non-Hazardous (may carry pathogens, potentially causing infection if not treated).	Waste streams from sanitary water systems.	NE	NE	Contained in the Waste Water Treatment Plant (WWTP).	Sent to approved regional domestic waste handling facility.
Glycol, Triethylene Glycol	Glycol: Toxic, Hazardous Triethylene Glycol: Non-Hazardous, not a WHMIS controlled product.	Circulated through the integrated glycol system for heating and cooling purposes.	7 m^3	37 m^3	In a closed system. Store in steel drums or tanks away from sources of heat or spark. Provided spill/leak containment.	Filter and reuse on-site. Return to supplier if product has not been contaminated. Send to a waste receiver for regenerant.
Methanol	Flammable, Toxic, Hazardous.	Injected to the fuel gas system to prevent the formation of gas hydrates. Injected into spent H2S scavenger to prevent gelling.	1 m^3	6 m^3	Store in steel drums on barrel dock or in steel tanks. Store in a well ventilated area away from heat sources.	In fuel gas system. Reuse when possible or send to an ERCB approved oilfield waste receiver.
Sweetening Agents	Flammable, Toxic, Hazardous.	Contacted with produced gas to scavenge H2S.	2,301 m^3	12,446 m^3	Store in tanks or steel drums or other containers on barrel dock.	Send to an ERCB approved oilfield waste receiver. Class 1a or 1b disposal well.

Table 5.2-1 Anticipated Waste Types and Expected Quantities (continued)

Waste Type	Waste Characterization	Source of Introduction	Incremental Annual Volume (Phase J)	Projected Annual Volume (Phases A to J)	Storage Method and Location(s)	Disposal Method and Location(s)
Other Chemicals	Various.	Various.	5 m^3	29 m^3	Demulsified storage tank – main battery.	Return to supplier, reuse or recycle. Send to chemical reclaimer/chemical exchange if applicable. Send to an ERCB approved Class 1a or Class 1b disposal well.
Other Turnaround Wastes	Various.	Various.	NE	NE	Produced solids temporarily stored at sand cell for treatment. ERCB WM 082.	Mix with aggregate for dust control on roads or disposed of to 3rd party landfill.
Lime Sludge	Non-Hazardous (typically, but dependant on analysis of contaminants).	Waste from Warm lime Softeners, dewatered in centrifuges.	9,593 m^3	51,890 m^3	Store in metal bins.	Dewatered to 60% sludge. Send to approved ERCB oilfield waste processing facility or Class II landfill.
Solids						
Construction Material	Non-hazardous (assumed to be wood, plastic, metals, etc.). Hazardous (adhesives, paints, fibreglass, etc.).	From construction activities.	NE	NE	Segregate material. Use scrap metal and domestic waste bins. Contain insulation in plastic bags or other sealable container.	Send to an ERCB approved Class II landfill. Reuse materials when possible. Recycle plastics, rubber, wood, paper, metal, and drywall where practicable.
Contaminated Debris and Soils	Dependant on fluid/material analysis.	From unexpected spill events.	2,576 m^3	13,935 m^3	Temporarily stored at sand cell ERCB WM 082 until characterized; liquids to slop tank. Store material in sealed drums if saturated, or in a lined, diked area. Ensure secondary containment and protection from precipitation.	Sent to 3rd party oilfield waste receiver or Class II landfill.
Ion Exchange Resin	Non-Hazardous before service. Spent ion exchange resin may potentially be hazardous dependant on analysis of contaminants such as caustic or heavy metals.	Normally regenerated but must be discarded after a certain period of operation.	NE	NE	Store in sealed drums.	Send to an ERCB approved Class II landfill.

Table 5.2-1 Anticipated Waste Types and Expected Quantities (continued)

Waste Type	Waste Characterization	Source of Introduction	Incremental Annual Volume (Phase J)	Projected Annual Volume (Phases A to J)	Storage Method and Location(s)	Disposal Method and Location(s)
Other						
Drilling Waste: Cement, Gel Chemicals, Hydrocarbon, Frac Sand, Produced Sand, Well Workover Fluids	As per ERCB Directives 050 and 047.	Consumed during normal operation, housekeeping, and maintenance activities.	7,861 m^3	42,517 m^3	Not Applicable.	Disposal on-site.
Bin Wastes: Empty Containers, Scrap Metal, Domestic Waste, Thread Protector, Desiccant, Lube Oil, Misc. Waste, Filters, Rags, and Absorbents	Non-hazardous if clean and empty. Potentially hazardous dependant on contents or residual contents.	Consumed during normal operation, housekeeping, and maintenance activities.	462 m^3	2,501 m^3	Store empty drums on sides with all bungs securely in place. Use sorbent and or provide leak containment.	Return to supplier if possible. Triple rinse and send to a container or metal recycler.
Slop Oil: Crude oil Emulsion, Emulsion Sludge, Hydrocarbon Sludge, Organic Wash Fluids	Non-Hazardous (typically, but dependant on analysis of contaminants).	Typically generated due to process upset, also generated in smaller quantities during normal operation.	30,202 m^3	163,358 m^3	Store in tanks.	Recycle emulsion to process when possible. Send to an ERCB approved oilfield waste receiver.

1. FCTP Phases F,G,H and J values are prorated from Phases A to E waste data values based on increased production capacity.
2. Annual volumes are estimated based on FCTP Phases A to E waste data reported for 2011
3. NE = Not Estimated. The annual volume of a few waste types in Table 5.2-1 could not be estimated. These waste types are not required to be tracked pursuant to Directive 058; therefore, volumes are not available. For these waste types, the estimated volume is given as NE.

5.2.1 Waste Minimization

5.2.1.1 Segregation and Storage

Segregation and interim storage are key elements to Cenovus's waste management strategy. By properly segregating and storing waste, the possibilities for waste reuse and recycling are maximized, while the possibility of cross-contamination is minimized. Waste segregation also allows for reduction of waste handling, treatment and disposal costs.

The FCTP has infrastructure in place for waste collection and storage prior to transportation, treatment and recycling/disposal. Construction during Phase J may require temporary waste and recyclables storage sites and containers. These will be provided at all points of waste generation. Separate and appropriate containers will be located for sorting of waste types at these sites.

Waste types will be sorted according to their:

- waste classification (i.e., storing hazardous and non-hazardous waste separately);
- compatibility characteristics (chemical, biological and physical); and
- final destination (i.e., recyclable materials will be stored separately from waste intended for disposal).

The three key containment methods employed by the Project and their associated requirements include the following:

- Primary Containment – ensure the integrity of all primary containment devices for waste, including all associated equipment such as valves, fittings, piping and pumps.
- Secondary Containment – use waste storage and transportation containers that prevent leaks. Containment could include leak detection and weather protection for storage facilities. Secondary containment will be provided for all oilfield wastes, excluding domestic garbage and debris.
- Ponds – the Project will utilize the existing Phase FGH storm water pond. The pond is described further in Section 5.7.

Operation and management of storm water ponds includes procedures, maintenance practices and inspection programs to maintain the integrity of the ponds and reporting requirements as per EPEA Approval No. 68492-01-00.

5.2.1.2 Recycling and Disposal

All off-site waste disposal and recycling will be completed at an approved facility for the designated waste types (Table 5.2-1). Most of the solid waste streams generated by the Project including spent ion exchange resin, construction material and contaminated debris and soil will be transported off-site to an approved third-party landfill or approved waste receiver.

Cenovus has a number of approved disposal wells for the disposal of regen wastes and boiler blowdown. These wells will continue to be used for the disposal of waste fluid streams and new disposal wells will be drilled and completed on an as required basis to handle the increased disposal flow rates associated with the Project.

The FCTP uses a water recycle program which takes produced water (derived from the reservoir recovery process) and uses it during steam production.

Cenovus currently uses a water-based drilling fluid system. Drilling mud will be temporarily stored in remote tanks. Standard Cenovus drilling leases include on-site storage for solid wastes. The on-lease, above-ground storage areas may include an area for benign solid cuttings, and tankage for slightly contaminated material, and areas for contaminated cuttings.

For any remote sumps that may be required, Cenovus will aim to use existing cleared areas and to reuse the same sites. Cement returns will either be buried as per Directive 050 (ERCB 2012) or possibly incorporated into access roads or well pads for aggregate following Directive 058 (ERCB 1996). All drilling waste disposal will be conducted in accordance with the requirements outlined in Directive 050, or any special approvals received from the ERCB.

Cenovus's current methods for handling drilling waste have the following environmental benefits:

- smaller environmental footprint;
- on-site sumps reduce emissions, noise and travel of large vehicles;
- on-site sumps reduce the amount of equipment required on-site;
- reduced need for remote cement pits;
- reduced tree clearing; and
- easier reclamation.

Determination of the final disposal method for drilling fluids and solids will be determined on the basis of the analytical results of waste sampling, with environmental concerns given primary consideration.

5.3 EFFICIENCY OPTIMIZATION

The Project design incorporates proven technology and related pollution prevention and waste management systems. Project design includes energy optimization measures, which include recovery of heat from the following streams:

- produced emulsion;
- steam generator blowdown;
- gas turbine generator exhaust; and
- produced gas.

The Project will also include the use of low-grade heat from produced water, produced gas, sales oil and disposal water for steam generator air preheat and space heating in buildings via a closed loop glycol circulation system.

The Project was designed to reduce air emissions through energy efficiency, which minimizes fuel consumption. To the extent practicable, surplus heat will be recovered by cross-exchanging the BFW with hot process streams. Preheating the BFW will reduce the fuel gas consumption of the OTSGs and HRSG. Trim cooling and process cooling will recover additional heat that will be used for building heating, heat tracing, tank coils and combustion air pre heating. The glycol will be circulated throughout the CPF for both heating and cooling requirements. Glycol required for cooling will be cooled in the glycol cooler and then fed to the heat exchangers in the CPF on demand. This will reduce additional energy demands helping to increase efficiencies and reduce emissions. The steady-state energy balance is provided in Table 5.3-1.

Table 5.3-1 Facility Energy Balance (Foster Creek Phase A-J)

Facility Energy Balance (Foster Creek Phases A-J)	Hydrocarbons (Sm^3/sd)	Energy (GJ/sd)
Energy Input		
Bitumen	46,825	1,994,627
Diluent	20,068	668,913
Produced Gas	1,170,625	40,256
Natural Gas	6,237,834	229,846
Electrical Power (Imported)		0
Total		**2,933,643**
Energy Output		
Sales Oil (Bitumen + Diluent)	66,893	2,663,541
Electrical Power		1,097
Losses		269,006
Uses		0
Total		2,933,643
Energy Efficiency		**90.8%**

The design has also included emission reduction measures, which include:

- installation of a vapour recovery unit (VRU) to capture vapours from process vessels and storage tanks;
- installation of gas sweetening facilities; and
- use of low NO_X burners.

5.4 FOOTPRINT MINIMIZATION

The development of the Project footprint incorporated both environmental and engineering constraints to guide the placement and size of the surface facilities. The purpose of constraints planning is to reduce or minimize environmental effects and to identify areas of low sensitivity that are more suitable for planned development. Environmental constraints considered in Project footprint siting include:

- Topography – preference for high, stable ground, with facilities located to minimize watercourse crossings and limit interference with natural drainage.
- Soils – preferred siting of facilities on mineral soils in upland settings and avoidance of Organic wetland soils, where practical.
- Vegetation – avoiding rare plants and limiting disturbance in old growth forest areas.
- Surface water – maintaining a 100 m setback from water bodies and watercourses for all Project components, where practicable.
- Sensitive habitat – adjusting sites to avoid direct impact (e.g., species-specific sensitive habitat)
- Historical resources and culturally significant sites – considering traditional land use and avoiding existing historical resource and culturally significant sites.

Cenovus will use existing ROW clearings wherever practicable to minimize surface disturbance and endeavour to combine the road, power line and pipeline ROW to optimize the use of cleared areas. Pipeline locations considered pipeline operability and safety.

Site selection for the Project CPF considered factors including constructability and technical and economic limitations for siting the infrastructure. The size of individual production well pads is determined by the number of well pairs that are to be drilled from each pad (Volume 1, Section 4), and is minimized to the area required for well pad construction, well drilling, operations and safety. The locations of the well pads were based on Cenovus's current understanding of the reservoir in order to maximize sub-surface access to the oil sands resource target. As further reservoir delineation information is available, the actual locations may shift; however, the footprint of individual well pads will be submitted for regulatory approval before surface disturbances occur.

5.5 FACILITY DIAGRAMS

Plot plans of the Project CPF are presented in Volume 1, Appendix B. New facilities associated with the Project are outlined in Section 5.1.2.

5.6 MATERIALS STORAGE

5.6.1 Process Tanks

All tanks will meet the requirements of ERCB Directive 055 – Storage Requirements for the Upstream Petroleum Industry (ERCB 2001) for secondary containment. In addition, storage tanks containing sour liquids or volatile hydrocarbons will be connected to the VRU system. The process and storage tanks required for the Project are presented in Table 5.6-1. Tank locations can be found on the Project plot plans, provided in Volume 1, Appendix B.

Table 5.6-1 New Storage Tanks Required for the Project

Tank Description	Tag Number	Nominal Capacity (m^3)	Fluid Stored	Vapour Recovery
BFW Tanks	FC3-T-0201D/E	TBC	BFW	Yes
Blowdown Recycle Tank	FC3-T-0210B	4,259	Start up OTSG/HRSG Blowdown, BFW Charge Pump minimum flow, miscellaneous PSV reliefs	No
Sales/Off-Spec Oil Tank	FC3-T-0401D	6,360	Sales Oil or Off-Spec Oil	Yes
Diluent Tank	FC3-T-0402C	2,459	Diluent	Yes
Glycol Storage Tank	FC3-T-0501B	85	60 wt% Tri-Ethylene Glycol	No
Glycol Pop Tanks	FC3-T-0507F/G	85	60 wt% Tri-Ethylene Glycol	No
Fresh Chemical Tank	FC3-T-0515B	160	H_2S Scavenger (Triazine)	No
Spent Chemical Tank	FC3-T-0516B	160	Spent H_2S Scavenger (Triazine), Sulphur, H_2S, Water	No
Methanol Tank	FC3-T-0520B	64	Methanol	No
Skim Tank	FC3-T-0701D	3,468	Produced Water from FWKOs and Treaters, Recovered Produced Water from Flash Treater, Slop Tanks, and Desand Tanks	Yes
Disposal Tank	FC3-T-0705B	778	Excess Deoiled Produced Water for Disposal	Yes
ISF Froth Tank	FC3-T-0706D	124	Skim Oil from Skim Tanks and oily froth from ISF vessels	Yes
Neutralization Tank	FC3-T-0825D	322	Neutralized WAC Regen Waste	Yes

Depending on the type of service, storage tanks will be protected from corrosion by various methods, including;

- internal coating (painting);
- internal corrosion allowance;
- internal cathodic protection (sacrificial anodes);
- external cathodic protection (impressed current); and
- material of construction (e.g., chemical storage tanks will be fibreglass or plastic that will not corrode with the given chemical).

The Project tanks and storage elements will be visually inspected on a regular basis to assess the integrity of containment and detect leaks.

5.7 WASTEWATER AND RUNOFF

5.7.1 Wastewater Process Streams

The Project wastewater streams include surface runoff, steam generator blowdown, produced water, and regeneration wastes.

Surface runoff at the Project CPF will be collected in the approved Phase FGH West Storm Pond. The pond has a design maximum capacity of 29,100 m^3 of water. Based on a Phase FGH and J plot space drainage area of 37.2 ha and an impervious ratio of 0.60, the storm water collection volume required for a 1:25 year, 24 hour storm event is 17,800 m^3. Therefore, the pond design for the Phase FGH West Storm Pond is adequate for the Phase FGH and J plot space runoff potential.

As described in the Phase FGH regulatory application (EnCana 2009), the liner system for the West Storm Pond includes re-compaction of the native clay base followed by the placement of a synthetic liner with a hydraulic conductivity no greater than 1×10^{-7} centimetres per second. A system of berms, drainage ditches and culverts will control and contain surface runoff and direct it to the Phase FGH West Storm Water Pond. A storm water lift station will direct the Phase J plot space runoff to the storm water pond.

In the event that extra standby capacity is required in the Phase FGH West Storm Water Pond, the collected surface water runoff will be sampled, as per the AESRD EPEA approval conditions, and released to the surrounding watershed through an overland discharge. The discharge location is designed to minimize erosion and sedimentation in the surrounding environment. If accumulated surface water does not meet regulatory requirements, it will be introduced into the CPF water treatment process. Additional information regarding the Project CPF storm water collection system is provided in Volume 1, Section 6 (Facilities).

Well pads will be configured to collect and contain surface run-off in one portion of the pad plot space. Berms and contouring will be used to contain surface water within the pad surface and direct the water to the surface water containment area. Runoff in the containment area will be tested to confirm that the water quality meets the parameter limits outlined in the EPEA Approval before being discharged overland to the surrounding environment. Water will be released in a manner that will minimize erosion or impacts to watercourses. Water not meeting the required guidelines will be sent through the CPF water treatment process.

Steam generator blowdown, regeneration waste and excess produced water will be routed to designated Class 1B disposal wells, each completed in the Basal McMurray Formation. A more detailed discussion of wastewater disposal is provided in Section 5.7.2.

5.7.2 Wastewater and Runoff Disposal

There will be no wastewater or runoff disposal to watercourses or waterbodies. Runoff release overland at the CPF and well pads is described above.

5.7.2.1 Disposal by Deep Well Injection

Process wastewater (blowdown, excess produced water, and regeneration waste) generated from the CPF will be routed to designated on-site Class 1B disposal wells, completed in the Basal McMurray Formation. Based on the depth, thickness, confinement, aquifer properties and water quality, the McMurray Formation is the most feasible wastewater disposal zone for the Project. Wastewater will be disposed where the total dissolved solids (TDS) concentration of the McMurray Formation is greater than 10,000 mg/L TDS. To minimize surface disturbance, Cenovus will utilize existing multi-well disposal pads completed for the FCTP Phase A-H operations. The legal land descriptions for the disposal well pads are as follows:

- Disposal Pad ED1 (11-02-070-04 W4M) - existing
- Disposal Pad ED2 (06-34-069-04 W4M) - existing
- Disposal Pad ED3 (15-19-69-03 W4M) – under development

In addition, future contingent disposal well pads may be developed, as required, at 30-69-03 W4M, 19-70-02 W4M and 20-70-02 W4M to accommodate disposal for the FCTP. These locations are optimal due to the extensive basal aquifer thickness and minimal bitumen saturation that allows for water disposal with minimal affect to bitumen recovery. The need for additional water disposal wells will be determined based on the Produced Water to Steam Ratio (PWSR) observed for the Project.

5.7.3 Wastewater and Runoff Monitoring

Monitoring of surface runoff will follow the EPEA approval conditions. An Industrial Wastewater and Industrial Runoff Report will be submitted to AESRD on an annual basis, or as required in the EPEA approval.

Wastewater disposal wells will be drilled, completed, tested and operated following all requirements outlined in ERCB Directive 051: Injection and Disposal Wells (ERCB 1994). The wellhead injection pressure and injection rate for each well will be monitored on a daily basis.

5.7.4 Treated Wastewater Monitoring

Cenovus does not propose to release process wastewater to the surrounding watershed. Treated wastewater release monitoring is not required for the Project.

5.8 AIR TREATMENT AND CONTROL

5.8.1 Air Emission Streams

The Project emissions will result from stacks that will operate on a continuous basis or on an intermittent standby basis and fugitive emissions from the plant and hydrocarbon storage tanks. Table 5.8-1 provides a summary of the Project CAC emissions. Emissions of SO_2, NO_X, CO and $PM_{2.5}$ are primarily associated with combustion stack emissions while VOC and TRS emissions occur mainly from fugitive plant and storage tank emissions. The approach and assumptions used to calculate the Project emissions are provided in Volume 3 Appendix 2A.

Table 5.8-1 Foster Creek Thermal Project CAC Emissions

Source	Emission Rate (t/d)					
	NO_x	SO_2	$PM_{2.5}$	CO	VOC	TRS
Stack Emissions						
Phase A-E Continuous Stacks	6.22	1.46	0.47	16.1	0.31	0
Phase FGH Continuous Stacks	4.31	0.38	0.33	12.8	0.25	0
Osprey Continuous Stacks	0.05	0.00	0.01	0.28	0.01	0
Phase J Continuous Stacks	***2.97***	***0.20***	***0.22***	***7.05***	***0.14***	***0***
Fugitive Plant Emissions						
Phase A-E Tank Emissions	0	0	0	0	0.60	0.0016
Phase A-E Process Area Emissions	0	0	0	0	0.05	0.00022
Phase FGH Tank Emissions	0	0	0	0	0.90	0.0015
Phase FGH Process Area Emissions	0	0	0	0	0.07	0.000086
Phase J Tank Emissions	***0***	***0***	***0***	***0***	***0.25***	***0.00037***
Phase J Process Area Emissions	***0***	***0***	***0***	***0***	***0.03***	***0.000055***
Construction Emissions						
Phase J Construction Emissions	0.25	0.00	0.01	0.26	0.04	0
Emission Totals						
Phase A through H Total	**10.6**	**1.84**	**0.80**	**29.2**	**2.19**	**0.0034**
Phase J (Project) Total	**2.97**	**0.20**	**0.22**	**7.05**	**0.42**	**0.00043**
Total	**13.6**	**2.04**	**1.03**	**36.2**	**2.61**	**0.0039**

Notes:
Construction HC emissions were considered VOC emissions in this summary table.
Construction emissions are not included in the Operational Emission Total

Plot plans of the Project CPF are presented in Volume 1 Appendix B. The stack dimensions, exhaust temperature and velocity, and emission rates are identified in Tables 5.8-2. The relative location of the Project emission sources at the CPF and the buildings/tanks that have potential downwash effects are provided in the plot plans. The Project will include the following sources of emissions:

- six OTSG stacks;
- three glycol heater stack;
- one co-generation unit;
- emergency diesel generators; and
- fugitive emission sources.

The Project will not involve the construction of new flare stacks. During upset events for the Project, flaring will occur at the approved Phase FGH flare stacks. The inlet gas compositions associated with continuous stacks and upset flare scenarios are given in Table 5.8-3.

Table 5.8-2 Summary of Project Stack Emissions

Source Type	Capacity (Heat Input)	Stack				Emission Rate					
		Height	Diameter	Velocity	Temp	SO_2	NO_X	CO	$PM_{2.5}$	VOC	TRS
	MW	m	m	m/s	K	t/d	t/d	t/d	t/d	t/d	t/d
OTSG (FC3-B-0213)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
OTSG (FC3-B-0214)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
OTSG (FC3-B-0215)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
OTSG (FC3-B-0216)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
OTSG (FC3-B-0217)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
OTSG (FC3-B-0218)	93.7	30	1.7	18	483	0.029	0.32	1.0	0.026	0.019	0
Glycol Heater (FC3-H-0501E)	11.3	9.5	0.9	6.1	468	0.000	0.025	0.034	0.0031	0.0022	0
Glycol Heater (FC3-H-0501F)	11.3	9.5	0.9	6.1	468	0.000	0.025	0.034	0.0031	0.0022	0
Glycol Heater (FC3-H-0501G)	11.3	9.5	0.9	6.1	468	0.000	0.025	0.034	0.0031	0.0022	0
Cogen (Turbine + HRSG)	208	30	3.3	23	474	0.021	0.97	0.95	0.053	0.024	0
Totals						**0.20**	**2.97**	**7.05**	**0.22**	**0.14**	**0**

Notes:
Heat Capacity is provided on an HHV basis and represents fuel input.
The Cogen capacity is 145 MW for the turbine and 63 MW for the HRSG.

Table 5.8-3 Gas Compositions (Mole Fraction) for the Project

Compound	Natural Gas	Mixed Fuel Gas	Upset Flare
Water	0.000084	0.0021	0.011
Hydrogen	0	0	0
Helium	0	0	0
Nitrogen	0.02	0.017	0
CO_2	0.0003	0.017	0.14
H_2S	0	0.00012	0.0048
Methane	0.98	0.96	0.82
Ethane	0	0	0
Propane	0	0.00035	0.0016
i-Butane	0	0.00028	0.0011
n-Butane	0	0.0015	0.0056
i-Pentane	0	0	0.0041
n-Pentane	0	0.0031	0.0043
n-Hexane	0	0	0.0008
	0	0	0.0027
Total	1	1	1

5.8.2 Central Processing Facility Emission Sources

5.8.2.1 Once Through Steam Generators

There will be six OTSGs fired on a mixture of sweetened produced gas and natural gas (mixed gas) at the Project CPF. A summary of the steam generation emissions is presented in Table 5.8-2. The emission rates from the steam generators were determined as follows:

- The SO_2 emission rates for the steam generators were calculated based on the sulphur content in the mixed fuel gas (sweetened produced gas and natural gas) at a maximum sulphur inlet rate of 9.9 t/d and a stream-day sulphur recovery rate of 90% (calendar-day sulphur recovery of 89.7%) as per ERCB sulphur recovery guidelines (EUB 2001).

- The NO_X and CO emission rates for the OTSGs are based on the emission limits provided in the CCME National Emission Guideline for Commercial/Industrial Boilers and Heaters (CCME 1998).
- The $PM_{2.5}$, and VOC emission rates were calculated based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).
- The TRS and H_2S emission rates were assumed to be negligible.
- The greenhouse gas emission rates were based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).

5.8.2.2 Glycol Heaters

There will be three glycol heaters fired on natural gas at the Project CPF. A summary of the glycol heater emissions is presented in Table 5.8-2. The emission rates from glycol heaters were determined as follows:

- The SO_2 emission rates were assumed to be negligible for the glycol heaters, which are fired with natural gas.
- The heater NO_X and CO emission rates were calculated based on the emission limits in the CCME National Emission Guideline for Commercial/Industrial Boilers and Heaters (CCME 1998).
- The $PM_{2.5}$, and VOC emission rates were calculated based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).
- The TRS and H_2S emission rates were assumed to be negligible.
- The greenhouse gas emission rates were based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).

5.8.2.3 Co-generation Unit

The electrical needs of the Project will be primarily satisfied by the cogeneration unit located at the Project CPF. The cogeneration unit will consist of one natural gas-fired turbine and a HRSG fired on a mixture of sweetened produced gas and natural gas (mixed gas). The turbine will have a maximum electricity output of approximately 50 MW. A summary of the cogeneration emissions is presented in Table 5.8-2. The following is the basis for estimating the emission rates from the cogeneration unit:

- The SO_2 emission rate was assumed to be negligible for the natural gas-fired turbine.

- The SO_2 emission rate for the HRSGs was calculated based on the sulphur content in the mixed fuel gas (sweetened produced gas and natural gas) at a maximum sulphur inlet rate of 9.9 t/d and a stream-day sulphur recovery rate of 90% (calendar-day sulphur recovery of 89.7%) as per ERCB sulphur recovery guidelines (EUB 2001).

- The NO_X emission rates from the cogeneration units were calculated based on the emission limits in the Canadian Council of Ministers of the Environment (CCME) National Emission Guidelines for Stationary Combustion Turbines (CCME 1992). For gas-fired cogeneration units, the CCME guidelines provide a more stringent NO_X

emission limit compared to the Alberta Air Emission Standards for Electricity Generation (AENV 2005b).

- The CO, $PM_{2.5}$, and VOC emission rates from the gas turbine were based on emission factors from Chapter 3.1 of AP-42 (U.S. EPA 1998).
- The CO emission rate from the HRSG was based on the emission limits in the CCME National Emission Guideline for Commercial/Industrial Boilers and Heaters (CCME 1998).
- The $PM_{2.5}$, and VOC emission rate from the HRSG was based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).
- The TRS and H_2S emission rates from the cogeneration unit were assumed to be negligible.
- The greenhouse gas emission rates, which include carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) from the gas turbine, was based on emission factors from Chapter 3.1 of AP-42 (U.S. EPA 1998).
- The greenhouse gas emission rate from the HRSG was based on emission factors from Chapter 1.4 of AP-42 (U.S. EPA 1998).

5.8.2.4 Emergency Flares

The Project will use the approved Phase FGH HP and LP flare, as needed during upset conditions. Under normal operating conditions, small volumes of sweet purge gas are directed to the Phase A-E and Phase FGH flare stacks. There is no continuous flaring from any of the flares; however, emissions from the flare pilots were included in the assessment (Volume 3, Appendix 2A).

During upset conditions, which are expected to be infrequent and typically of a short-term nature, larger volumes of gas including those from the Project, will be directed to the flare stacks. Three potential upset scenarios associated with the FCTP were assessed, including:

- **Phase A-E Plant Inlet Blockage**: Produced gas will be flared by the Phase A-E HP flare stack (S-505). This upset is expected to last up to one hour. The other phases will continue to operate normally. This assessment examines the overlap of the Phase A-E HP flare upset with normal emissions assumed for the Phase FGH and Project (Phase J) sources.
- **Phase FGH and J Plant Inlet Blockage**: Produced gas associated with Phase FGH and J will be flared out of the Phase FGH HP flare stack (FC3-S-0501). The Phase FGH plant will continue normal operation by burning sweet pipeline gas in the steam generators. This upset is expected to last up to one hour. This assessment examines the overlap of the Phase FGH HP flare upset with normal emissions assumed for the Phase A-E sources.

- **SRU Inlet Blockage**: All produced gas will be flared out of the SRU emergency HP flare stack. The entire CPF (including Phase A-E, Phase FGH and Phase J) will continue normal operation by burning sweet pipeline gas in the emission sources.

The ERCB Directive 60 flare assessment tool (ERCB Flare spreadsheet) was used to calculate flare stack parameters and SO_2 emission rates associated with each scenario. The flare stack dimensions and emissions for each scenario are provided in Table 5.8-4.

5.8.2.5 Flare Pits

There are no flare pits associated with the Project.

Table 5.8-4 Emergency Flare Stack Project Emissions

Source Type	Gas Flow Rate	Capacity	Stack		Emission Rate				
			Height	Diameter	SO_2	NO_X	CO	$PM_{2.5}$	VOC
	10^3 Sm^3/d	MW	m	m	t/d	t/d	t/d	t/d	t/d
Phase A-E Plant Inlet Blockage	503	199	30.5	0.305	8.6	0.5	2.7	0.11	1
Phase FGH and J Plant Inlet Blockage	648	256	30.5	1.15	11.2	0.65	3.5	0.14	1.3
SRU Inlet Blockage	1,151	454	29.0	0.305	19.8	1.1	6.2	0.25	2.4

Notes:
Stack height and diameter are actual values. Pseudo stack values are presented in Volume 3, Appendix 2A.
Capacity is provided as heat input in HHV.
Flare events are expected to occur infrequency – approximately 2 times per year for a 1-hour duration, respectively.

5.8.2.6 Emergency Power Generation

There will be three 2 MW diesel generators installed at the Project CPF to provide emergency back-up power for the Project. The generators will be an intermittent emission source and will not be used during normal operations. Consequently, their emissions were not included in the assessment.

5.8.2.7 Plant Fugitive Emission Sources

A total of four new hydrocarbon storage tanks are proposed for the Project. Three are bitumen tanks and the remaining one is a diluent tank. All of these tanks are blanketed and are tied into a VRU to manage potential fugitive emissions that may result from emptying and filling operations (referred to as working losses) and from diurnal heating and cooling of the tanks (referred to as breathing losses).

Fugitive emissions are also associated with small leaks from valves, flanges, seals, and drains. Fugitive emissions for the Project were identified and fugitive emissions are estimated on the basis of equipment count and stream content. Fugitive emissions from the different plant process areas were calculated and used as input into dispersion modelling as 50 individual area sources to represent the different location, magnitude and composition of fugitive emissions throughout the plant. Fugitive VOC and TRS emissions associated with hydrocarbon storage tanks and plant leaks are shown in Table 5.8-1. Fugitive VOC emissions associated with tank and plant leaks are 0.25 t/d and 0.03 t/d, respectively. Fugitive TRS emissions associated with tank and plant leaks are 0.00037 t/d and 0.000055 t/d, respectively. Emission rates for each tank and for the different plant areas are presented in Volume 3, Appendix 2A.

Fugitive emissions associated with the hydrocarbon tanks were estimated per the following:

- The latest version of U.S. EPA TANKS was used to calculate total hydrocarbon emissions based on the tank properties and contents using Cold Lake region meteorology.
- A control efficiency of 95% was assumed for tanks tied into a VRU, which is the minimum level of control specified for vapour control systems by the CCME *Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Aboveground Storage Tanks* (CCME 1995).
- The compositions of the fugitive emissions were based on representative product analysis of the tank contents and Raoult's Law.

Fugitive emissions from component leakage will result from the numerous valves, flanges, rotating seals, and drains that are associated with the Project. Fugitive emissions were estimated based on equipment counts for each area of the plant and on applicable emission factors. Vessel, pump, compressor, heater/boiler and valve counts were determined from the project process flow diagrams (PFDs). Component counts for valves not shown on PFDs, connectors, PSVs and OELs were based on the default equipment schedule for similar process unit published by CAPP (CAPP 1999). The leak/non-leak emission factors published by U.S. EPA (1998) for oil and gas production operating units were used for emissions estimation representative product analysis of the different process streams.

5.8.3 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions from the Project are mainly comprised of carbon dioxide (CO_2) from stationary gas-fired combustion sources (i.e., steam generators, turbines and heaters) and methane (CH_4) from fugitive emission sources (i.e., fugitive storage tanks and process leaks). GHG emissions are normally reported as CO_2-equivalent (CO_{2e}) which accounts for CO_2, methane and nitrous oxide (N_2O) having global warming potentials that are 1, 21 and 310 times that of CO_2 on a weight basis.

GHG emissions were estimated for the operation and construction phases of the Project. The GHG emissions for the operation phase are associated with three types of emission sources:

- gas-fired stationary combustion sources;
- fugitive emission sources; and
- operations vehicle fleet exhaust.

GHG emissions at the Project site will occur from construction of the CPF, the initial well pads, the access roads, and pipeline and power line corridors. The average GHG emissions are 54.2 t/d CO_{2e} for construction activities.

During Project operations, GHG emissions result from combustion sources and fugitive sources. In estimating GHG emissions from Project stacks, all the stacks were assumed to be operating at full load on a continuous basis, which would be a conservative representation of emissions at full production. Project GHG emissions of 3,534 t/d or 1,290 kt/a is almost entirely attributable (99^{+}%) to combustion sources.

A summary of Project GHG emissions is provided in Table 5.8-5. More details regarding GHG calculations and assumptions are provided in Volume 3, Appendix 2A.

Table 5.8-5 Estimated FCTP GHG Emissions

Source	Emission Rate (t/d)			
	CO_2	CH_4	N_2O	CO_2e
Stack Emissions				
Phase A-E Continuous Stacks	8,836	0.16	0.13	8,881
Phase FGH Continuous Stacks	5,162	0.13	0.09	5,193
Osprey Continuous Stacks	109	0.00	0.00	110
Phase J Continuous Stacks	***3,487***	***0.070***	***0.062***	***3,508***
Fugitive Plant Emissions				
Phase A-E Tank Emissions	0.32	5.3	0	112
Phase A-E Process Area Emissions	0.53	4.5	0	96
Phase FGH Tank Emissions	0.038	0.15	0	3.08
Phase FGH Process Area Emissions	0.038	0.072	0	1.56
Phase J Tank Emissions	***0.13***	***1.2***	***0.00***	***25***
Phase J Process Area Emissions	***0.010***	***0.039***	***0.00***	***0.83***
Construction Emissions				
Phase J Construction Emissions	53.6	0.0026	0.0016	54.2
Emission Totals				
Phases A through H Total	***14,108***	***10.3***	***0.2***	***14,396***
Phase J (Project) Total	***3,487***	***1.3***	***0.062***	***3,534***
Total	***17,595***	***11.6***	***0.29***	***17,930***

Note:
Construction emissions are not included in the Operational Emission Total.

5.8.4 Air Emissions Management

To manage air emissions, Cenovus has incorporated a number of mitigation measures into the design of the Project. These include:

- low-NO_X burner technology for the once-through steam generators (OTSGs), HRSG and heaters to comply with the applicable NO_X and CO emission levels specified by CCME (1998);

- low-NOx burner technology for the gas turbine generator (cogeneration unit) to comply with the applicable NO_X and CO emission levels specified by CCME (1992). For the gas-fired turbine, the CCME guidelines provide a more stringent NO_X emission limit compared to the *Alberta Air Emission Standards for Electricity Generation* (AENV 2005).

- sulphur recovery facility (SRF) that removes sulphur from produced gas. The SRF removes a minimum of 90% of the inlet sulphur consistent with the ERCB sulphur recovery guidance;

- operation of the FCTP flare systems will be managed in accordance with ERCB Directive 060 (ERCB 2006) and AESRD EPEA approval conditions;

- combustion of produced gas in the OTSGs, as opposed to direct venting or flaring, offers the advantage of more reliable and complete combustion, reducing the opportunity for the formation of incomplete combustion products;

- centralization of emissions from the field to the Project CPF will result in lower impact compared to that of scattered sources (e.g., individual well pad flares) due to more complete combustion and better dispersion;

- cogeneration units are used to recovery the heat produced as part of power generation reducing the usage of steam generators;

- steam generators are designed to operate at a high efficiency (i.e., above 84% on a high heating value basis) reducing fuel consumption and emissions;

- steam lines are insulated to minimize heat losses associated with the transport of steam to the well pads reducing steam requirements;

- limiting continuous flare stack emissions to a pilot in the flares at the CPF. Flaring due to upset/emergency conditions, start-up, and commissioning will be minimized to the extent practicable;

- a vapour recovery unit (VRU) to capture vapours from the process vessels and storage tanks thereby reducing fugitive tank emissions;

- partial redundancy in VRU compressors to minimize emissions during potential VRU upsets;

- above ground storage tanks to conform to the Environmental Guidelines for Controlling Emissions of Volatile Organic Compounds from Above Ground Storage Tanks (CCME 1995); and

- direct inspection and maintenance (DI&M) techniques will be applied to achieve efficient management of fugitive emissions from equipment leaks, which includes daily walk-throughs by operations personnel, use of gas detection monitoring systems, and effective repairs and after-repair monitoring program.

More detailed information describing the Project design is provided in Volume 1, Section 6, Facilities.

5.8.5 Ground Level Concentrations

The CALPUFF model was applied to predict ambient SO_2, NO_2, and $PM_{2.5}$ concentrations.

The maximum SO_2, NO_2, and $PM_{2.5}$ concentrations for the Baseline and Application Case that are predicted:

- on the Project CPF fence line;
- outside Project CPF fence line and inside LSA; and
- outside LSA and inside RSA.

5.8.5.1 Regional SO_2 Predictions

A comparison of the Baseline Case and Application Case SO_2 maximum predictions (excluding the developed area) within the RSA and the LSA is provided in Table 5.8-6. The comparisons indicate that there is a small predicted increase in SO_2 concentrations along the Project CPF fenceline and that maximum SO_2 concentrations in the LSA and RSA are relatively unchanged from the Baseline Case, for all averaging periods. The maximum 1-hour, 24-hour, 30-day and annual SO_2 concentrations all remain below the AAAQO levels in both the RSA and the LSA.

Table 5.8-6 Predicted Baseline and Application Case SO_2 Concentrations

Location	Averaging Period	AAAQO (μg/m³)	Maximum Predicted SO_2 Concentrations Outside of Developed Area (μg/m³)		
			Baseline Case	Application Case	Percent Change
On Project CPF Fence Line	1-hour (9th-high)	450	105	107	1.14
	24-hour (2nd-high)	125	41.3	42	1.70
	30-day (1st-high)	30	11.8	11.9	0.76
	annual	20	7.49	7.64	2.00
Outside Project CPF Fence Line and within LSA	1-hour (9th-high)	450	266	266	0.00
	24-hour (2nd-high)	125	99	99	0.00
	30-day (1st-high)	30	22.5	22.5	0.04
	annual	20	13.1	13.2	0.08
Outside LSA and within RSA	1-hour (9th-high)	450	175	175	0.01
	24-hour (2nd-high)	125	48.9	48.9	0.00
	30-day (1st-high)	30	12.1	12.1	0.00
	annual	20	6.57	6.58	0.15

Notes:
The % change is with respect to the Baseline Case.
Background concentration of 2.6 μg/m³, 1.8 μg/m³, 1.5 μg/m³ and 0.57 μg/m³ have been added to the model results for the 1-h, 24-h, 30-day and annual averaging periods respectively.
Developed area defined as the Project CPF
Compliance with the 1-hour AAAQO is based upon the 9th-high 1-hour value (AENV 2009a). Compliance with the 24-hour value is based upon the 2nd-high 24-hour value (AESRD 2011).

5.8.5.2 Upset Flare SO_2 Predictions

Intermittent flaring events are evaluated in Volume 3, Appendix 2E. For the three flaring events, the results are as follows:

- **Phase A-E Plant Inlet Blockage scenario**: The maximum predicted 1-hour SO_2 concentrations within and along the Project CPF fence line are 255 μg/m^3 and 96.2 μg/m^3, respectively.
- **Phase FGH Plant Inlet Blockage scenario**: The maximum predicted 1-hour SO_2 concentrations within and along the Project CPF fence line are 254 μg/m^3 and 99.1 μg/m^3, respectively.
- **SRU Inlet Blockage scenario**: The maximum predicted 1-hour SO_2 concentrations within and along the Project CPF fenceline are 22.1 μg/m^3 and 22.8 μg/m^3, respectively. The maximum predicted 1-hour SO_2 concentrations within the LSA is 29.4 μg/m^3 Maximum predicted concentrations are lower for the SRU Inlet Blockage scenario as sulphur emissions occur from only the flare stack, which results in better dispersion associated with the height of the flare stack and plume rise due to combustion of the flared gas.

Due to the limited duration of intermittent events, 24 hour and annual average SO_2 concentrations changes due to these events were not examined.

5.8.5.3 Regional NO_2 Predictions

A comparison of the Baseline Case and Application Case ground-level NO_2 predicted concentrations (excluding the developed area) within the LSA and the RSA is provided in Table 5.8-7. The comparisons indicate that there is a small predicted increase in NO_2 concentrations along the Project CPF fence line and that maximum NO_2 concentrations in the LSA and RSA are relatively unchanged from the Baseline Case, for all averaging periods. The maximum 1-hour and annual NO_2 concentrations all remain below the AAAQO levels in both the RSA and the LSA.

Table 5.8-7 Predicted Baseline and Application Case NO_2 Concentrations

Location	Averaging Period	AAAQO (μg/m³)	Maximum Predicted NO_2 Concentrations Outside of Developed Area (μg/m³)		
			Baseline Case	Application Case	Percent Change
On Project CPF Fence line	1-hour (9th-high)	300	140	149	7.09
	annual	45	15.2	16.3	7.16
Outside Project CPF Fence line and within LSA	1-hour (9th-high)	300	159	159	0.00
	annual	45	27.0	27.2	0.59
Outside LSA and within RSA	1-hour (9th-high)	300	146	146	0.00
	annual	45	29.6	29.6	0.02

Notes:
The percent change is with respect to the Baseline Case.
Background concentration of 20.7 μg/m³ and 3.76 μg/m³ have been added to the model results for the 1-h and annual averaging periods respectively.
Developed area defined as the Project CPF
Compliance with the 1-hour AAAQO is based upon the 9th-high 1-hour value (AENV 2009a).

5.8.5.4 Regional $PM_{2.5}$ Predictions

A comparison of the Baseline Case and Application Case ground-level $PM_{2.5}$ predicted concentrations (excluding developed area) within the LSA and the RSA is provided in Table 5.8-8. The comparisons indicate that there is a small predicted increase in $PM_{2.5}$ concentrations along the Project CPF fenceline and that maximum $PM_{2.5}$ concentrations in the LSA and RSA are relatively unchanged from the Baseline Case. Maximum $PM_{2.5}$ concentrations on the Project CPF fenceline and in the LSA are less than the AAAQG and AAAGO.

Within the RSA, maximum $PM_{2.5}$ concentrations are predicted to exceed the AAAQG and AAAQO in the communities of Bonnyville and Lac La Biche. The $PM_{2.5}$ concentrations predicted in these communities are associated with vehicle emissions and urban and commercial heating emissions.

Table 5.8-8 Predicted Baseline and Application Case $PM_{2.5}$ Concentrations

Location	Averaging Period	AAAQG and AAAQO (μg/m³)	Maximum Predicted $PM_{2.5}$ Concentrations Outside of Developed Area (μg/m³)		
			Baseline Case	Application Case	Percent Change
On Project CPF Fence line	1-hour (9th-high)	80	34.6	41.3	19.6
	24-hour (2nd-high)	30	17.9	18.4	2.80
Outside Project CPF Fence line and within LSA	1-hour (9th-high)	80	52.1	52.1	0.00
	24-hour (2nd-high)	30	27.6	27.6	0.00
Outside LSA and within RSA	1-hour (9th-high)	80	96.8	96.8	0.05
	24-hour (2nd-high)	30	50.6	50.7	0.05

Notes:
The % change is with respect to the Baseline Case.
Background concentration of 9.4 and 8.1 μg/m3 have been added to the model results for the 1-h and 24-h averaging periods respectively.
Developed area defined as the Project CPF
Compliance with the 1-hour AAAQO is based upon the 9th-high 1-hour value (AENV 2009a). Compliance with the 24-hour value is based upon the 2nd-high 24-hour value (AENV 2011).

5.8.6 Equipment Performance Evaluation

Routine operational maintenance at the facility will include an inspection of the air emission sources and their relative performance. Cenovus will evaluate the applicability of new control technologies as they become available.

5.8.7 Monitoring Programs

The follow-up monitoring planned by Cenovus includes two components: source monitoring, which measures the emissions from the Project, and ambient monitoring that measures nearby ambient air concentrations. To a large extent, the requirement for source and ambient monitoring procedures is established by AESRD through the development of the terms and conditions in the EPEA approval.

The current EPEA approval for the FCTP requires that Cenovus undertake the following regular source monitoring:

- Manual NO_X stack survey on one of the Phase A-E 53.7 MW steam generators stacks on an annual basis.
- Manual NO_X stack survey on two the Phase A-E and three of the Phase FGH 93.9 MW steam generator exhaust stacks on a rotating basis.
- Continuous Emissions Monitoring (CEMS) for NO_X for two the Phase A-E and three of the Phase FGH 93.9 MW steam generator exhaust stacks.
- For each of the 117 MW heat recovery steam generators, manual NO_X stack survey twice per year as well CEMS.

- Twice annual manual stack survey and CEMS to measure SO_2 emissions from the sulphur recovery facility incinerator stack.
- In addition, manual stack surveys are required for new steam generators and glycol heaters within six months of commissioning
- Continuous monitoring of volumetric flow rates of produced and fuel gas to flare stacks, steam generators, heat recovery steam generators and flare stacks. Monthly analysis of produced gas or combined fuel gas.

Cenovus expects that similar stack surveys and CEMS will be required for the Project.

Ambient air monitoring for Foster Creek is conducted through LICA. The current EPEA approval for the FCTP specifies that Cenovus shall participate in the LICA air quality monitoring program network. Cenovus satisfies this monitoring requirement through participation in LICA.

5.8.8 Air Emissions Waste Streams

Air emission sources from the facility are described in Section 5.8.1 and 5.8.2. There are no additional liquid or solid waste streams associated with air emissions.

6 CONSTRUCTION CONSIDERATIONS

6.1 CONSTRUCTION SCHEDULE

Pending regulatory approval and market conditions, Project construction is scheduled to begin in Q1 2015 with initial production anticipated in 2018 (Section 3.4, Table 3.4-1). The Project will be constructed sequentially, with construction of the CPF expansion expected to begin in 2015 and its commissioning (first steam) forecast for 2018. Construction activities will include clearing of vegetation, site preparation and installation of infrastructure and equipment.

Cenovus will construct SAGD well pads in sequence, which will be dictated by the need to ramp up to full production and to sustain the CPF output design. An estimated 78 well pairs on nine initial well pads are forecast to be operating within twelve months of Project operation start up. Some wells will remain in production longer than planned if bitumen recovery remains high, where practical, potentially delaying replacement well pad construction. If bitumen recovery is lower than expected, then additional well pads may be developed earlier to maintain level-loading of the CPF. Once bitumen recovery ends at a SAGD well pad, decommissioning and reclamation of the pad will follow. The maximum production life of SAGD well pads is anticipated to be 15 to 17 years.

6.2 CONSTRUCTION SITE LOCATION

6.2.1 Facilities Disturbance and Project Footprint

The Project footprint covers 975 ha, of which 57 ha has existing vegetation disturbance. Project facility types and the disturbance areas, including existing vegetation disturbance, are presented in Section 2.4, Table 2.4-1.

Field facilities for the Project include SAGD well pads, access roads, pipelines and utility corridors, a substation, a disposal well and borrow areas. ROWs for access roads, aboveground pipelines and power lines that connect the SAGD well pads to the CPF expansion will be combined in common access/utility corridors, where practical. Surface soil disturbance will occur mainly at the CPF expansion, SAGD well pads, access roads, substation and borrow areas.

A typical SAGD well pad will occupy an area of 4 ha. The dimensions of the planned SAGD well pads are approximately 195 m by 205 m, but their final dimensions will vary according to engineering designs. The layout of a typical well pad and access is presented in Volume 1, Appendix G.

6.2.2 Siting and Disturbance Minimization

Environmental and engineering considerations have been included in Project planning and design and are discussed in detail in Section 5.4.

6.2.3 Sensitive Soils

Sensitive soils include soil types that are susceptible to wind and water erosion, and soils that remain wet or saturated from spring to autumn. Detailed discussions on the sensitivity of soil to wind and water erosion and acidification is described in Volume 5, Section 11, Terrain and Soils. Wind erosion and water erosion risk is presented on Figures 4.3-3 and 4.3-4. Soils at risk to wind and water erosion are mapped within Project areas including the following:

- CPF expansion;
- a number of SAGD well pads;
- a number of borrow areas;
- along aboveground pipeline, power line and access road ROWs; and
- substation.

The soils most sensitive to wind erosion include aaBitumount (aaBMT-1, aaBMT-2) Liza (LIZ-1, LIZ-2) and Moose Hills (MHL-1). Erosion of these sandy soils can be mitigated by ensuring that soil stripping activities does not occur during winds where soil drifting is sustained. Appropriate stockpile management practices discussed in Section 6.5 will be employed to protect all soil stockpiles against wind erosion.

The SMUs with high risk to water erosion are Athabasca (ABC-1 and ABC-2) and Lisa (LIZ-1 and LIZ-2), where the slopes are greater than 9% in hummocky or ridged to strongly rolling topography. These soils in these landforms would be susceptible to water erosion when left bare and un-vegetated. Soil stockpiles will be protected against water erosion by using appropriate stockpile management practices (Section 6.5).

The subsoil (B horizon, where present) of the Gleysolic soils (aaBitumount and aaSteepbank) in low-lying areas typically remains wet or saturated throughout the year. Where present, the upper subsoil is very susceptible to being compacted, rutted and degraded by construction equipment in unfrozen conditions. Wet soils are more susceptible to compaction than dry or slightly moist soils (Hillel 1982). No mapped soil areas have been identified as having unsuitable subsoil, as described in SQCRDR (AAFRD 1987).

The mitigation measures proposed for the Project to reduce the effects on terrain and soils during construction include, but are not limited to, the following:

- using existing disturbances (e.g., common access roads; combining access and utilities into a common ROW), where practicable, to reduce the extent of new clearing;.
- designing corridors to minimize duplicate access to infrastructure, where practical;
- limiting the number of SAGD well pads by locating multiple well pairs on each pad and planning adjacent, contiguous SAGD well pads where practical;
- limiting initial disturbance by planning well pad progression, where practical;
- reducing SAGD well pad area to the extent practical by surface infrastructure, operations requirements and salvaged soil storage;
- salvaging topsoil separately from subsoil using two-lift stripping, where practical;

- stockpiling soil on stable surfaces and using erosion mitigation measures, as needed;
- avoiding salvage of topsoil and upper subsoil in unfrozen, wet or saturated conditions where practical;
- limiting salvage of Organic soil under frozen conditions where practical; and
- having qualified environmental personnel supervise soil salvage and handling, to ensure that admixing of LFH/peat/topsoil with subsoil material is minimized, and confirm that soil conservation and mitigation measures are applied.

Topsoil and subsoil salvage handling will be suspended if wet or unfrozen conditions occur, or high wind velocities prevail, to prevent degradation of mineral topsoil or subsoil quality. Construction will be suspended or postponed when soil is wet and unfrozen to avoid damage to soil structure and prevent erosion. Construction will be suspended during periods of heavy runoff (e.g., heavy rain or snowmelt events).

Factors to be used to postpone start-up or shut-down of work will include:

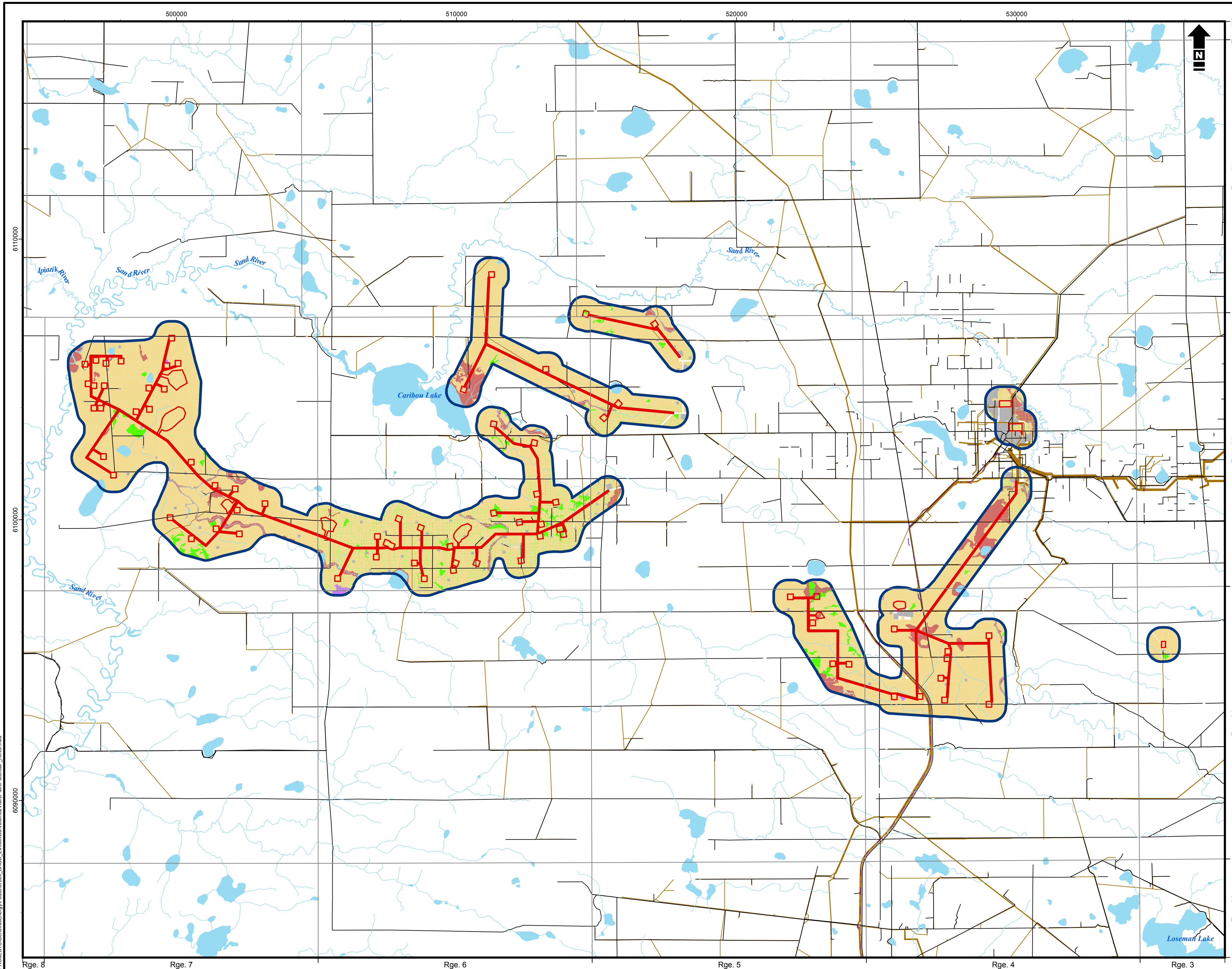
- weather forecast;
- construction schedule; and
- availability of well-drained soils.

6.2.4 Sensitive Vegetation

Sensitive vegetation is defined as rare plants, rare plant communities and plant communities of limited distribution. Rare plant potential is a ranking used to summarize the spatial extent and distribution of potential rare plant habitat in the Terrestrial LSA and RSA (Figure 6.2-1). Rare plant potential was considered in constraints mapping for the Project. Detailed discussion on rare plants and plant communities are provided in Volume 5, Section 12, Vegetation. Rare plants and rare plant communities in the Terrestrial LSA are presented on Figure 4.3-6.

Mitigation measures for rare plants and rare communities found in the Terrestrial LSA will be implemented during planning and construction (e.g., avoidance, transplanting), where practical. Rare plant locations were considered in constraints mapping for the Project and all occurrences were avoided. The following summarizes the proposed mitigation measures for rare plants and plant communities of limited distribution to reduce Project effects on rare plants and plant communities:

- To protect rare plants, the Project footprint may be adjusted, rare species may be transplanted and/or seeds may be collected for use in reclamation strategies. These mitigation strategies will be implemented according to the species' life history characteristics, distribution, response to disturbance and threats to the species. A decision for transplantation will be based on the status of the rare plant species (Alberta Conservation Information Management System ranks S1 and S2, listed on the watch list, or globally rare [G1, G2, G3] on the tracking list).



Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline
Anthropogenic Disturbance

Rare Plant Potential

1 Very Low (i1, i2, SO)
2 Low (a1, b1, b1-regen, b2, b3, b4, c1, d1, d2, d3, g1, j1, j2, k1, HF, HG)
3 Medium (e1, e2, h1)
4 High (f1, f2, k2, k3, SR)

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

1:130,000

2.5 0 2.5
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Rare Plant Habitat Potential in the Terrestrial Local Study Area

Date: 19 Feb 2013
Project: 11029-514
Technical: M.Moss
Reviewer: R.Lauzon
Drawn: T.Graham

Disclaimer: Prepared solely for the use of Cenovus FCCL Ltd. as specified in the accompanying report. No representation of any kind is made to other parties with which Cenovus FCCL Ltd. has not entered into contract.

Figure 6.2-1

Pre Disturbance Assessment and Conservation & Reclamation (PDA/C&R) Plan or subsequent processes that may replace PDA/C&R Plans will be undertaken before the development of each Project component, to help mitigate loss of critical habitat for rare plants.

6.3 CONSTRUCTION AND SITE DIAGRAMS

Construction activities will occur within the Project footprint (Project components are identified in Figure 2.4-1). If additional temporary workspace is required during construction, Cenovus will obtain the appropriate authorization from AESRD. Scale diagrams of the CPF are provided in Volume 1, Appendix B, and a typical well pad for the Project is provided in Volume 1, Appendix G.

6.4 MANAGEMENT OF RECLAMATION MATERIALS

Construction methods will depend on site-specific surface conditions. Construction of Project facilities will include berms, ditches, culverts and grading to manage runoff, as needed.

Potential effects to soils during construction and operations that present some constraints for reclamation include:

- wind and water erosion on large areas of exposed soils;
- compaction of very moist to wet, fine textured soil;
- reduction of topsoil organic matter content from admixing of topsoil and subsoil; and
- instability of cut slopes in coarse textured soils.

Mitigation to address potential impacts to soils is presented in the following sections.

6.4.1 Upland Sites

Since surface soils are important determinants of land capability, the following measures for mineral soil salvage will be followed to conserve soil quantity and quality:

- To preserve salvaged topsoil quality, qualified environmental personnel will supervise soil salvage to ensure minimal admixing of subsoil with LFH/peat/topsoil material. Site-specific soil handling will be presented clearly in the PDA/C&R Plans of finalized facility locations before construction begins. Inspections in existing disturbed areas will be done during PDAs to assess the conditions of the vegetation and soil in the disturbances prior to construction.

- Soil salvage and handling will be suspended if wet or high wind velocities will result in degradation of soil quality. Soil handling activities will resume with the return of favourable conditions.

- Topsoil will be stripped and handled separately from subsoil and the materials will be stockpiled individually.

- Shallow peat (depth less than 40 cm) will be preferably salvaged under dry or frozen conditions.
- Where appropriate, salvaged topsoil will be spread onto an upland disturbance that is in reclamation (direct placement), and is approved by AESRD.

Soil salvage plans take into account the distribution and characteristics of the mapped soils for conservation of surface soil quality and quantity. Surface soils for salvage in uplands generally consist of LFH, A and B soil horizons, and also shallow peat layers that are common in the wetter (Gleysolic) mineral soils, many of which lack an A horizon. General mineral soil salvage guidelines are provided for soil series found in the LSA in Table 6.4-1.

Table 6.4-1 Soil Characteristics Related to Soil Salvage in the Terrestrial Local Study Area

Main Soil Series	Parent Material	General Topsoil Salvage	Topsoil Thickness Range (cm)	Comments (colours, sensitivities)
Brunisolic Soils				
Liza	Glaciofluvial	Salvage all topsoil material (LFH or shallow peat ('O' horizon, plus all 'A' horizon soil).	6 – 39	Very light grey topsoil Ae varies from sand to loamy sand and has high risk to wind erosion when exposed; the yellowish brown to brownish yellow Bm subsoil can often be used to guide stripping depth; exposed topsoil or subsoil has a high risk to wind erosion.
Luvisolic Soils				LFH or thin Of overlays Ae; colour change from the greyish Ae topsoil to the brown Bt subsoil can often guide topsoil stripping depth.
Athabasca	Till	Salvage all topsoil material (LFH or shallow peat ('O' horizon), plus all 'A' horizon soil).	11 – 40	Topsoil texture varies from sand to silt loam and loam; sandy loam to clay loam; Bt subsoil susceptible to rutting and compaction when very moist or wet.
Moose Hills	Glaciofluvial over Till		16 – 47	Grayish to light yellowish brown topsoil Ae with texture from sand to loamy sand and has moderate risk to wind erosion when exposed; olive brown Bt horizon varies in texture from loamy sand to sandy clay loam/clay loam.
Gleysolic Soils				Shallow peat at surface is common; water table may be present in topsoil or subsoil horizons.
aaBitumount	Glaciofluvial	Salvage surface peat ('O' horizon) or LFH and, where present, the underlying 'A' horizon soil.	8 – 58	Dark coloured peat and a greyish Ae horizon, if present, has a sand to loamy sand texture; the B subsoil is dull gray to yellowish brown and varies in texture from sand to sandy loam.
aaSteepbank	Till		5 – 55	Dark coloured peat and a thin dark A horizon, if present, over dull gray or olive brown B; the subsoil varies from loam to clay loam textures and it is susceptible to rutting and compaction when very moist or wet.

The LFH or shallow peat (less than 40 cm) materials will be salvaged and stockpiled with 'A' horizon mineral topsoil. More site-specific soil salvage guidelines (including topsoil thicknesses and volumes) will be developed before construction in the PDA/C&R Plans (AENV 2009) of finalized sites.

CPF Expansion and Well Pads

Construction of the CPF expansion, disposal and SAGD well pads, and access roads on upland areas involves clearing, timber salvage, disposal of woody debris, soil salvage, grading (including cut and fill as required) and gravelling. Where fill is required, the subgrade is compacted and fill is deposited in layers and compacted.

Surface or first lift of soil material typically consists of organic materials (LFH and/or shallow peat 'O' layer) and all 'A' horizon mineral soil. A second lift of up to 30 cm of suitable subsoil, as defined in SQCRDR (AAFRD 1987) will be salvaged at the CPF expansion, disposal well pad and SAGD well pad locations, except where the subsoil is too wet for soil handling. Salvage of subsoil is usually not possible in low-lying areas where the mineral subsoil remains wet or saturated, and is very susceptible to being compacted and rutted (Hillel 1982). Subsoil that is too wet for stripping and handling is often encountered in the Gleysolic soils, which are often associated with a shallow water table.

Pipelines and Access Roads

The *Code of Practice for Pipelines and Telecommunications Lines Crossing a Water Body* (AENV 2006a), *Code of Practice for Watercourse Crossings* (AENV 2006b), applicable Fisheries and Oceans Canada (DFO) Operational Statements (DFO 2007) and other applicable guidelines will be followed during construction of pipelines and access roads at watercourse crossings.

After a ROW is cleared for pipelines or power lines, the slash and coarse woody debris left after burning will be replaced as rollback along the ROW. Minimal soil disturbance occurs over most of the ROW and is limited to where pipe support rack piles are installed. Revegetation of the ROWs will be mainly by natural regeneration. If regeneration is slow or an area is prone to erosion, these areas will be planted with native woody species and/or revegetated with an AESRD-approved mix.

Single-lift salvage of topsoil materials is planned for the access roads, to minimize the area required for salvaged soil storage within the access ROW. A cross-sectional view of the utility corridor for the Project is presented in Volume 1, Appendix G.

Borrow Areas

The potential borrow areas have been located primarily on mineral soils, which have developed on till, glaciofluvial deposits over till, or glaciofluvial deposits. The borrow areas will only be disturbed to the extent that the material is required for the Project. Final borrow area locations will be confirmed for suitability after geotechnical investigations are completed as a requirement of applications for a surface land disposition (ASRD 2008) through AESRD. Glaciolacustrine and till/glacial till deposits are preferred for borrow areas, although peat or thin glaciofluvial deposits overlying glaciolacustrine or till can also provide borrow material.

Initial borrow area locations on the coarse textured Liza and Moose Hills soil series might require site-specific assessment to determine if the depth of excavation to suitable fill material is feasible. Construction of borrow areas generally involves timber salvage, clearing, disposal of woody debris, two-lift soil salvage and extraction of fill. Soil stockpiles stored on-site will be placed on stable areas. Borrow areas will be reclaimed progressively, where practicable, as they are exhausted of useful material (Section 8.3.2.3).

6.4.2 Peatlands (Organic Soil)

In Organic soil areas in peatlands, clearing and construction under frozen conditions will be preferred where practical. There is generally no salvage of surface peat planned in peatlands, except for the peaty Gleysolic soils that are transitional (less than 40 cm peat) between uplands and peatlands. In Organic soils of peatlands, geotextile will be placed on the peat surface after the vegetation is cleared and woody debris is flattened or piled and burned. Borrow fill material will be deposited over the geotextile in layers and compacted to the appropriate pad height. The pad surface will then be graded and gravel will be spread on the areas required for operations.

Access roads in peatlands will be constructed over geotextile or geogrid, which will be placed on the surface of the peat after the vegetation is cleared. The roadbeds will be constructed using borrow fill and the road surfaces will be gravelled, with culverts placed in the access roads to maintain water flow, which is important in fens. The spacing and number of culverts installed will be on an as-needed basis.

Constraints that might be encountered with construction of sites on deep peat include water management when constructing pads, and compression of peat beneath the weight of a padded site. The use of a corduroy woody debris layer on the peat surface before geotextile is placed increases the weight bearing strength at the surface of peat before a pad is constructed, and acts as a defining layer between the covered peat and the overlying fill. No subsoil will be salvaged from the Organic soils because no peat from Organic soils will be salvaged.

6.4.3 Sites Partly on Upland and Partly on Peatland

For a well pad that will disturb both mineral and Organic soils, topsoil and subsoil salvage will be done on the upland part of the site before the portion in peatland is constructed. The pad area in peatland will be constructed with a geotextile layer over peat and using lower subsoil cut from the upland area as fill, which might be supplemented with borrow fill as required. In the areas of shallow peat (less than 40 cm of Of/Om/Oh) of Bitumount and Steepbank soils, the peat will be salvaged with the A horizon, where present. Shallow peat that is salvaged will be stockpiled and a portion of it might be used for direct placement on sites that will be at the appropriate stage of reclamation. Salvage of upper subsoil is usually not possible in low-lying Gleysolic soil areas where the subsoil remains permanently too wet for stripping and soil handling.

6.5 RECLAMATION MATERIALS STORAGE

For most Project sites, salvaged soil will be stockpiled at the site of origin, if it is not used for direct placement during reclamation of another FCTP site. The stockpile locations and volumes will be signed, and records (as-built details) on stockpiles will be maintained. Salvaged soil materials will generally be stored on like material (e.g., topsoil on topsoil, subsoil on subsoil). Long-term soil stockpiles will be located so that they are:

- on stable and dry ground;
- in areas where they do not intrude on construction and operations;
- in areas accessible and retrievable for reclamation;
- outside treed areas and with breaks in soil windrows along access roads to accommodate water flow; and
- kept separate by a minimum of 1 m between piles of different soil materials, berms or adjacent undisturbed forest.

The salvaged topsoil and subsoil will be stockpiled separately at the Project CPF site (Volume 1, Appendix B). The on-site location of the topsoil and subsoil stockpiles at a borrow area will be site-specific. To help preserve biological activity during soil storage and maintain viability of a portion of plant propagules, the topsoil for access roads will be spread along the access ROW ditches and the adjacent power line ROW, where applicable (AENV 2010a; Mackenzie and Naeth 2009). Where this is not practicable, soil salvaged from roadways will be stored on existing disturbances (e.g., log decks, abandoned well sites, retired borrow areas).

Stockpiles will generally not be higher than 8 m at the Project CPF. Soil stockpiles will be contoured to a stable slope gradient and erosion control measures will be undertaken as needed (e.g., seeded with a certified, AESRD approved seed mixture, use of tacking agent or erosion matting, and/or silt fence). An example seed mix for interim reclamation use in northeast Alberta is presented in Table 6.5-1. An annual cereal might be planted (40 kg/ha to 50 kg/ha) to compete with weeds, with reference to pre-development weed information. The mix might also be applied to exposed soil along access roads to control potential erosion. Weed management for the stockpiles will be maintained (Section 6.6.4).

Table 6.5-1 Example Native Seed Mix Suitable for Soil Stockpiles and Bare Areas

Common Name	Scientific Name	Percentage
Awned wheat grass	*Agropyron trachycaulum var. unilaterale*	25
Nodding brome or Fringed Brome	*Bromus anomalus* or *Bromus ciliatus*	25
Canada wild rye	*Elymus canadensis*	20
Tufted hair grass	*Deschampsia caespitosa*	10
Fowl bluegrass	*Poa palustris*	10
June grass	*Koelaria macrantha*	5
Tickle grass	*Agrostis scabra*	5

6.6 TIMBER, VEGETATION, EROSION AND WEED MANAGEMENT

There is no FMA holder with the Crown for commercial timber management within the CLAWR; however, merchantable timber will be salvaged during clearing operations.

6.6.1 Merchantable Timber

Merchantable timber, defined as having a breast height diameter of 15 cm or greater, will be salvaged according to utilization standards, where the volume is greater than 50 m^3/ha (*Timber Management Regulation and the Forest and Prairie Protection Act Regulations Parts 1 and 2*). A feller-buncher will be used for clearing and merchantable timber will be stored on deck sites for removal.

General guidelines for timber salvage activities include the following:

- using timber decks (in order of preference) on existing cleared areas, in non-merchantable timber stands, and lastly, in merchantable timber stands;
- avoiding reforested cutovers (cutblocks) for log decks;
- decking logs with the butt ends facing in the same direction; and
- removing merchantable timber from the ROWs and Project sites.

6.6.2 Vegetation Clearing

Vegetation clearing will be limited to the extent that will allow the completion and operation of the Project. Land will be cleared in accordance with the *Migratory Birds Convention Act*, *Timber Management Regulations and the Forest and Prairie Protection Act* and related regulations and guidelines (e.g., provincial restricted activity periods [RAPs]), as they apply to site clearing and woody debris disposal. Fire fighting equipment, in accordance with provincial guidelines and relative to the degree of fire hazard, will be available on-site during Project construction.

Where practicable, areas previously cleared will be used and clearing activities will occur on frozen or dry ground conditions to minimize effects to soils and root mats. Avoidance is a primary mitigation tool for rare plants. To protect rare plants (i.e., Species at Risk Act listed, ACIMS ranked S1 and S2, listed on the watch list, or globally rare [G1, G2, G3] on the tracking list), the Project footprint may be adjusted, where practicable. Alternatively, rare species may be transplanted and/or seeds may be collected for use in a suitable area in reclamation.

6.6.3 Non-Merchantable Timber

Non-merchantable trees and brush will be cleared using equipment to maintain ground surface integrity. Woody debris management will be carried out in accordance with Alberta regulations (*Forest and Prairie Protection Act Regulations*, Parts 1 and 2; *Timber Management Regulation* [ASRD 2001]) and current guidelines (e.g., *Management of Wood Chips on Public Land* [ASRD 2009]). A combination of techniques will be used to manage coarse woody debris (CWD) remaining after timber salvage, with the objectives of maintaining soil and ecological qualities, or stockpiling CWD for reclamation where possible, and maintaining a safe work environment. Techniques may include rollback on site periphery, piling, burning or mulching.

Tree stumps will primarily be mulched into CWD. Rollback that does not exceed approximately 50% ground coverage is a best management practice for the use of woody debris. Where woody debris is mulched into wood chips, the chips will not be mixed with topsoil. If wood chips are spread on reclaimed land, the thickness will not exceed 5 cm (ASRD 2009). A portion of the non-merchantable trees and brush will be piled and burned, to dispose of excessive woody debris and ensure fire safety. Approval will be obtained from Range Control before burning woody debris. Burning will only be done when the fire hazard is low or moderate.

In peatlands, equipment will knock down non-merchantable trees and shrubs. The woody debris will be laid flat and will be used to provide additional support as a “corduroy” layer, where practical, beneath geotextile and pad fill. CWD from upland disturbances may also be relocated for use as corduroy in peatlands, where practical.

6.6.4 Weed Management

The *Alberta Weed Control Act* is the primary legislation that addresses weed management and the enforcement of weed control in the province. The plant species designated as weeds are listed in the *Weed Control Regulation* - Alberta Regulation 19/2010. The Cenovus weed management procedures will be ongoing throughout all stages of construction, operation and reclamation. The procedure is also based on prevention, prompt identification and treatment of infestation, integrated control strategies, monitoring, and ongoing awareness and training). Examples of weed management practices to be undertaken by Cenovus include:

- limiting soil disturbance to areas required for completion of the Project;
- ensuring prompt revegetation with desirable native vegetation, where possible;

- ensuring that earth moving equipment arriving on-site is free of soil, or cleaned if necessary, to prevent the importation of weed seeds or other propagules;
- obtaining and reviewing certificates of seed analysis for seed to be used for the Project to understand the quality of the seed being sourced and to mitigate any weed issues that might be identified;
- avoiding persistent agronomic forage species for revegetation of reclaimed areas;
- limiting the use of straw bales or straw crimping to control erosion, and evaluating erosion control products containing straw for potential content of weed propagules;
- training production facility workers on problem weed matters and ensuring they participate in identification and reporting of prohibited noxious and noxious weeds to the environmental coordinator;
- destroying prohibited noxious weeds and controlling noxious weeds;
- keeping areas free of vegetation for fire control, including areas around buildings and equipment;
- use of integrated vegetation control strategies, where practical, that include chemical, mechanical/manual and biological methods, and are designed to address the specific physiology of the species in question;
- conducting mechanical/manual control of weeds (mowing, cultivation, hand picking), particularly near water and riparian (sensitive) areas; hand picking is the first option and mechanical means is second; hand-picked weeds will be placed in bags, sealed and burned either in the fall or winter where practical;
- hiring licensed pesticide applicators to select and spot apply herbicides in accordance with the Pesticide (Ministerial) Regulation, Alberta Regulation 43/1997 (Consolidated up to 315/2003); herbicides will be used only where necessary; and
- avoiding the use of soil sterilants for the Project.

Weed control measures will be undertaken in a timely manner. If required, herbicide application near a water body will be authorized through a “Special Use Approval” obtained through AESRD.

6.7 CONTAMINATION AVOIDANCE AND MANAGEMENT

Existing disturbances at the Baseline Case, which may have potential contamination, such as former industrial sites or abandoned oil and gas well sites, will be assessed as appropriate, typically with a Phase I environmental site assessment (AENV 2010b, 2010c). Based on the Phase I environmental site assessment results, a Phase II environmental site assessment may be required before construction, followed by appropriate remediation measures. If undertaken, remediation will be completed with the endpoints for applicable parameters based on remediation guidelines, as updated (AENV 2010b, 2010c).

6.8 ENVIRONMENTAL, SURFACE WATER AND EROSION MANAGEMENT

6.8.1 Environmental Management

During the construction and operations phases of the Project, wastes will be generated and there is potential for spills. Wastes generated during construction will be placed into the appropriate containers or receptacles onsite and will be stored at the approved FCTP waste handling and storage site. The procedures for spill response, waste handling and disposal of wastes will follow Cenovus's Emergency Response Plan (ERP). The main features of the Cenovus ERP are described below.

Spill Prevention

Cenovus's procedures are designed to prevent spills of fuel, lubricating fluids, hydraulic fluids, methanol, antifreeze, herbicides, biocides or other chemicals. Cenovus's well pads will include a perimeter berm and an internal ditch to provide spill containment on-site. All spills, whether associated with Cenovus operators or contractors, will be immediately reported to the responsible on-site environmental personnel and will be cleaned up. Emergency spill procedures are currently in place for the FCTP, and these procedures will be adopted and updated, as required, for the Project. The appropriate regulators will be notified of reportable spills according to the applicable legislation and regulations.

Disposal of Oilfield Waste

All waste will be handled, managed and disposed of according to the applicable regulatory requirements. Drilling waste management will comply with ERCB Directive 50 (ERCB 2012), including notifications, sampling, analysis and disposal. In addition to the ERCB Directive 50 requirements, disposal of drilling waste and reportable Project production waste at approved waste management facilities will be tracked and reported according to ERCB Directive 58 (ERCB 1996). Disposal of liquid wastes through injection wells will adhere to the requirements of ERCB Directive 51 (ERCB 1994). ERCB Directive 058 waste tracking requirements will be met for all reportable oilfield waste.

Further discussion of Project wastes management is presented in Section 5. Cenovus has reviewed specifications outlined in Directive 050 to determine the feasibility of incorporating benign solid drilling cuttings from SAGD drilling activities into access roads and well pads. Cenovus will submit applications for eligible sites and waste materials on a case by case basis.

Disposal of Non-Oilfield Waste

Liquid wastes, sludge and non-solid wastes that are unsuitable for disposal in disposal wells or Class II landfill will be moved to an appropriate disposal facility. Construction waste and domestic waste will be hauled to the nearest approved landfill. Cenovus will attempt to reduce, recycle and salvage waste streams as appropriate. No additional domestic wastewater facilities are proposed for the Project. Existing FCTP domestic wastewater facilities will be operated in accordance with the conditions of EPEA Approval. Sludge generated by the domestic wastewater system is disposed of at an approved facility.

6.8.2 Surface Water Management

Surface and near surface water management is focused on water supply, water recycling, and surface and ground water protection. Measures will be undertaken to manage runoff and maintain surface drainage patterns compatible with the surroundings in both uplands and peatlands. The SAGD well pads will have a perimeter ditch/berm system to prevent flow on site, to contain runoff and to meet the requirements of the EPEA Approval, as amended, for on-site containment of potential substance releases. To contain runoff water, the Project CPF design will include grading, berms, ditches, and a lift station (as required) that will direct runoff to the approved Phase FGH West Storm Water Pond. Examples of other water mitigation measures include:

- grading and constructing berms, interior ditching and directing runoff to a lined stormwater pond at the Phase FGH CPF to manage runoff water;
- construction of an internal ditch and berm system on SAGD well pads to contain runoff on-site and to collect it in one corner;
- construction of perimeter ditches, where necessary, to direct natural drainage around the facilities and prevent surface water run-on and prevent run-on flow from off-site;
- placing culverts in access roads to maintain water flow and constructing ditches where required along the access roads to maintain drainage and avoid unnatural pooling of water;
- following legislative requirements for minimal impact engineering for watercourse crossings and complying with applicable regulatory requirements such as:
    - *Code of Practice for Pipelines and Telecommunications Lines Crossing a Water Body* (AENV 2006a),
    - *Code of Practice for Watercourse Crossings* (AENV 2006b), and
    - *Fisheries Act;* Fisheries and Oceans Canada Operational Statements (DFO 2007).
- placing culverts and drains where required at well pads and in access roads in deep peat wetlands (e.g., fens) to maintain water flow; and
- monitoring the conditions at roads and pads to determine if additional measures (e.g., clear blocked culverts) are needed to maintain water flow in wetlands and maintain natural drainage.

Runoff that collects on the CPF expansion or well pads during construction will be tested to confirm that the runoff quality meets the parameter limits outlined in the EPEA Approval before being discharged to the environment, where required. Water will be released in a manner that will prevent erosion or impacts to the surrounding area, after obtaining a temporary diversion license under the *Water Act*. Water not meeting the guidelines will be sent to the FCTP CPF for re-use. Detailed mitigation measures for potential surface water impacts are provided in the EIA (Volume 4, Section 5.6, Aquatic Resources Introduction).

6.8.3 Erosion Mitigation

Erosion control measures will be used as required during construction, operation and reclamation stages; example measures include:

- using silt fencing or settling ponds during construction to contain sediment where practical;
- contouring disturbed surfaces to gentle slope gradients;
- using ditches, culverts and flow impediments where required to manage water flow and allow drainage; culverts will also be installed in access roads in fens;
- using water flow attenuation structures (e.g., rip rap, perforated berms, woody debris) to slow water velocity where required in ditches and particularly on exposed soil in moderate to strong slopes (10% to 30%);
- seeding ditches with an approved seed mix, and/or placing physical erosion protection (e.g., rip rap, perforated berms, fibre matting, woody debris) as required; the use of coconut matting is preferred to minimize the risk of introducing weed species and provide protection for a longer period than the straw of an annual crop;
- contouring soil stockpiles and other exposed soil areas to avoid excessive slopes and revegetating or otherwise protecting them to stabilize soil surfaces;
- postponing soil handling when significant erosion may occur (e.g., prolonged intense rainfall, high winds that will cause soil drifting), particularly for soil handling activities in the sandy aaBitumount and Liza soils;
- applying fresh water to manage dust on roads and bare soil during construction, operation and reclamation stages of the Project;
- installing silt fence along the perimeter of pads to capture any potential soil erosion from the sides of pads, before vegetative cover is established; and
- promptly addressing erosion observed as a result of Project activities or weather events.

Erosion mitigation will be important for construction and soil handling activities in sandy soil SMUs (i.e., aaBMT-1, aaBMT-2, LIZ-1, LIZ-2) and where moderate or strong slopes prevail (CPF expansion, Substation and in Twp. 70, Rg. 6, W4M). Long slopes present a risk of rill/gulley erosion from concentrated flow. This can be minimized by contouring to avoid concentrated flow down long slopes (e.g., perpendicular to slope track packing), or providing protected (e.g., vegetated) drainage ways.

6.9 CONSTRUCTION EMISSIONS

Emissions associated with construction activities include on road and off-road vehicle traffic, heavy equipment, heaters, and temporary power generation. Emissions were calculated for the construction phase of the Project (i.e., 2015 to 2018, prior to startup in 2018). The construction emissions are presented in Table 5.8-1. Construction emissions are equivalent to 4% (for CO) to 9.5% (for VOCs) of the continuous emissions associated with Project operations. As construction emissions are much less than operational emissions and construction is limited in duration, the construction activities were not considered in air emissions modelling.

6.10 ENVIRONMENTAL RELEASE MONITORING

Cenovus's spill response procedures during the construction phase will be the same as the spill response plan discussed in Volume 1, Section 9. The appropriate regulators will be notified of reportable spills according to the applicable legislation and regulations. Monitoring programs will follow regulatory requirements. Stormwater within the construction site will be used for dust control, or directed to the Phase FGH West Storm Pond and released to the surrounding area as described in Section 5.7.1.

6.11 AMBIENT MONITORING EQUIPMENT

As described in Sections 5.8.7 and 7.3.2, ambient air monitoring for Foster Creek is conducted through LICA. The current EPEA approval for the FCTP specifies that Cenovus shall participate in the LICA air quality monitoring program network. Cenovus satisfies this monitoring requirement through participation in LICA. Ambient air monitoring will be conducted throughout the construction phase via the LICA air quality monitoring program network.

7 OPERATIONS

7.1 REGULATORY RECORDS

In accordance with EPEA Approval conditions, record keeping procedures will be used to maintain copies of the application and correspondence with AERSD.

7.2 OPERATING PROCEDURES

Maintenance and quality management procedures for release monitoring and performance evaluation will be developed during detailed engineering of the Project and will build off of existing FCTP procedures.

7.3 JOINT MONITORING

Cenovus participates in government approved initiatives to address industry issues and re-visits its participation in such initiatives on an ongoing basis. A full list of initiatives relating to the Project is presented in Section 3.1. Initiatives which relate to the Project and joint monitoring are described in Sections 7.3.1 to 7.3.4.

7.3.1 Ecological Monitoring Committee for the Lower Athabasca

The Ecological Monitoring Committee for the Lower Athabasca (EMCLA) is a committee for the Alberta Biodiversity Monitoring Institute (ABMI). The purpose of the EMCLA is to progress the quality and consistency of monitoring done by various oil sands companies, in order for these companies to fulfill Environmental Protection and Enhancement Act requirements for their developments. The EMCLA supports a regional approach to monitoring, rather than an individual project approach. Cenovus funds the EMCLA and is an active industry member.

As stated in the EMCLA 3-Year Vision and 2013 Work Plan:

"Key priorities include:

- *Filling gaps in existing regional monitoring systems*
- *Coordinating data collection amongst multiple development projects*
- *Ensuring the key principles of transparency, scientific credibility, and relevance form the basis of new monitoring programs…*

The EMCLA's aim is that the regional wildlife and biodiversity monitoring required as part of EPEA approvals held by oil sands operators is carried out in a coordinated, efficient way that produces valuable knowledge for wildlife and biodiversity management."

7.3.2 Airshed Zone

The Airshed Zone is one of two independent standing committees of the Lakeland Industry and Community Association (LICA). Cenovus actively participates in the LICA Air Quality Monitoring Program for the region, as per EPEA Approval No. 68492-01-00, and currently holds an alternate seat as a committee member.

As stated on the LICA internet site, the purpose of the Airshed Zone Committee is three-fold:

- *Serve as the Alberta Airshed Zone in the LICA area, including participation in appropriate Federal and/or Provincial air quality initiatives.*
- *Facilitate and co-ordinate regional air quality monitoring in the LICA area.*
- *Further and promote understanding of air quality in the LICA area.*

The objectives of the committee are as follows:

- *Support public communication and awareness*
- *Determine background air quality and track trends*
- *Support protection of wildlife, livestock and ecosystems*
- *Support regulatory compliance*
- *Characterize pollutants in the LICA region*
- *Determine human exposure to air pollutants*
- *Assess trans-boundary effects*
- *Support model evaluation*
- *Combine partner resources and share best practices*

7.3.3 Beaver River Watershed Alliance

The Beaver River Watershed Alliance (BRWA) is one of eleven Government of Alberta-mandated Water Planning and Advisory Councils (WPACs). It is the second of the two independent standing committees of LICA, incorporating the participation of individuals and organizations. Through LICA, Cenovus is a financial supporter and active member of BRWA projects.

As stated of their internet site, the mission of the BRWA is as follows:

> *"The Beaver River Watershed Alliance will maintain or improve the ecology of the Beaver River Watershed while respecting the diverse values of watershed community. This will be achieved through broad community engagement, partnerships, sound scientific study, education, and the support and encouragement of implementing sustainable water management and land use practices."*

7.3.4 Canada-Alberta Oil Sands Monitoring Program

The Canada-Alberta Oil Sands Monitoring Program is a joint initiative between the Government of Canada and Alberta which builds on, and intends to enhance, existing monitoring activities in the oil sands region. As stated in the Plan (GoC, GoA 2012):

"*The purpose of the joint implementation plan is to describe how the Governments of Alberta and Canada will implement a world class monitoring program for the oil sands to provide assurance of environmentally responsible development of the resource. The plan has a number of objectives:*

- *Support sound decision-making by governments as well as stakeholders;*
- *Ensure transparency through accessible, comparable and quality-assured data;*
- *Enhance science-based monitoring for improved characterization of the state of the environment and collect the information necessary to understand cumulative effects;*
- *Improve analysis of existing monitoring data to develop a better understanding of historical baselines and changes, and;*
- *Reflect the trans-boundary nature of the issue and promote collaboration with the Governments of Saskatchewan and the Northwest Territories…*

Monitoring activities will be phased in over three years to ensure installation of necessary infrastructure, incremental enhancement of activities and appropriate integration with existing monitoring activities in the region… Monitoring commitments contained in the Implementation Plan are intended to further our understanding of current conditions and changes that have already occurred, improve characterization of the state of the environment on an ongoing basis and provide information to understand what is contributing to the cumulative effects in the oil sands area."

7.4 WASTEWATER CHARACTERIZATION TESTING

Cenovus complies with applicable regulations for wastewater characterization sampling and testing. Unless otherwise authorized in writing by the Director, Cenovus only disposes of industrial wastewater as follows:

- to the Phase A-H CPF water recycle treatment unit;
- to an ERCB approved disposal well; or
- to an ERCB approved Waste Processing and Disposal Facility.

7.5 RECORD KEEPING PROCEDURES

Cenovus will comply with the EPEA Approval for record keeping. Records will be retained for a minimum of ten years. Collection and analyses of samples will be recorded including;

- the place, date and time of sampling;
- the dates the analyses were performed;
- the analytical techniques, methods or procedures used in the analyses;
- the names of the persons who collected and analyzed each sample; and
- analytical results.

7.5.1 Reporting Procedures

Cenovus will comply with the EPEA Approval for reporting requirements including submission of:

- Monthly and Annual Air Emission Reports;
- Annual Industrial Wastewater and Industrial Runoff Report;
- Annual Groundwater Monitoring Report;
- Monthly and Annual Domestic Wastewater Reports;
- Comprehensive Wildlife Mitigation and Monitoring Report;
- Soil Monitoring Reports, and where required, annual Soil Management Program reports; and
- Annual Conservation and Reclamation Reports.

7.6 SPILL RESPONSE AND REPORTING PLAN

Cenovus's spill response procedures during the operations phase will be the same as the spill response plan discussed in Volume 1, Section 9. The appropriate regulators will be notified of reportable spills according to the applicable legislation and regulations.

Where required, a remediation system will be designed and implemented on a case by case basis with consideration of potential runoff and odour issues, where applicable. Groundwater, soil and air monitoring will be conducted for early detection of substance releases, where applicable. Additional information on the emergency response plan, waste management and spill response procedures is presented in Volume 1, Section 9.

7.7 WASTEWATER, WASTES AND SLUDGE MANAGEMENT PROCEDURES

Production wastes during operation will be placed in the waste storage area constructed to the requirements of ERCB *Directive 055 Storage Requirements for the Upstream Petroleum Industry* (ERCB 2001). Disposal of production wastewater will be undertaken in accordance with the requirements of ERCB *Directive 058 Addendum 2008-12-23: Oilfield Waste Management Facility* (ERCB 2008). Liquid disposal in injection wells will follow the requirements of ERCB *Directive 051 Injection and Disposal Wells, Well Classifications*

Logging, and Testing Requirements (ERCB 1994). ERCB Directive 058 waste tracking requirements will be met for all reportable oilfield waste. The Project will not accept third-party waste for disposal.

Process wastewater management is discussed in Section 5.7. Runoff stormwater testing and discharge into the environment is discussed in Section 5.7.1.

7.8 AIR EMISSION CONTROL EQUIPMENT MAINTENANCE

Detailed procedures and plans will be developed in accordance with regulatory requirements as Cenovus proceeds with detailed engineering of the Project CPF.

7.9 GROUNDWATER MONITORING AND MANAGEMENT PROCEDURES

To facilitate mitigation of unplanned events, an adaptive surface water/groundwater monitoring plan will be implemented. This surface water/groundwater monitoring plan will be:

- designed to be compatible with the *Lower Athabasca Region Groundwater Management Framework* (Government of Alberta 2012d), and
- communicated to AESRD and be in compliance with EPEA approval conditions.

Because surface water/groundwater monitoring of different Project operations overlap, one proposed monitoring well may be used for more than one groundwater monitoring objective.

The groundwater characterization and water quality monitoring component comprises a groundwater management plan (GMP) to be developed in consideration of the forthcoming groundwater monitoring directive, which is currently being developed by AESRD.

A more detailed GMP will be generated in consultation with AESRD and approved prior to implementation. In the event that residual effects to groundwater quality or quantity are identified through groundwater monitoring results, the Groundwater Response Plan will be implemented.

7.10 SOIL MONITORING AND MANAGEMENT

Soil monitoring of substances of concern, in accordance with the Soil Monitoring Directive (Government of Alberta 2009) will be undertaken for the Project to facilitate mitigation of unplanned events. Monitoring will provide feedback, where practical, on the effects of development and mitigation activities on the terrain and soil resources.

Operations personnel will monitor ditches, soil stockpiles and soil windrows for vegetation and signs of erosion. Deficiencies identified during monitoring will be mitigated. Monitoring activities will comply with the EPEA Approval.

7.11 WASTE CLASSIFYING AND CHARACTERIZING

Waste classification and characterization will be conducted according to *Alberta User Guide for Waste Managers - PART 1 – A* (AEP 1996).

7.12 SOIL STOCKPILE MANAGEMENT PLAN

The soil stockpile management plan discussed in Section 6.5 applies to the construction, operations and reclamation stages of the Project, until salvaged soil materials are replaced during reclamation.

7.13 OPERATOR CERTIFICATIONS

Cenovus will comply with the EPEA Approval and applicable legislation, for operator certification requirements.

8 FINAL RECLAMATION PLAN

8.1 CONCEPTUAL RECLAMATION PLAN

Cenovus is committed to reclaiming disturbances related to the Project to equivalent land capability. Equivalent land capability is defined in the *Alberta Conservation and Reclamation Regulation* (AR 115/93) as "the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to any activity being conducted on the land, but that the individual land uses will not necessarily be identical" (AENV 2008b). The reclaimed sites might not be identical to pre-development conditions after reclamation, but the post-reclamation land capability will not be diminished from the pre-development capability.

Conservation and reclamation practices that may be used to achieve the above objective involve:

- conserving existing reclamation materials where practical;
- adopting measures to limit or prevent (mitigate) potential environmental impacts;
- applying appropriate reclamation measures after decommissioning; and
- using adaptive management to incorporate improvements in construction and reclamation throughout all stages of the Project.

Cenovus will following the principles contained in the *Conservation and Reclamation Guidelines for Alberta* (AENV 1997) including:

- remediate and/or dispose of contaminants to meet regulatory requirements;
- re-contour disturbances to be compatible with the surrounding terrain and target end land uses;
- provide proper drainage and stability, and control erosion;
- not use surface soil for grading purposes;
- correct soil compaction where necessary;
- replace salvaged soils in the same sequence as found in the undisturbed areas, unless otherwise directed by the Director, as designated by the EPEA Approval;
- use native species or seed mixtures, where required, that will allow the establishment of native plant species compatible with the intended end land use; and
- manage noxious and prohibited noxious weeds.

Adjustments to the conceptual Reclamation Plan will be made on a site-specific basis to account for differences in topography, soils, vegetation and drainage. In accordance with regulatory requirements, PDAs are planned for finalized facility locations and associated detailed C&R Plan reports will be completed (AENV 2009b).

Cenovus consults with regulators and stakeholders, including indigenous communities. If any unique environmental issue arises, Cenovus, in consultation with AESRD, will engage appropriate environmental professionals, where practical, to address the issue and seek solutions.

8.1.1 Wildlife

Strategies to limit potential effects of Project activities on wildlife will be implemented, as described in the Volume 5, Section 10, Introduction, and in the Cenovus FCTP Wildlife Mitigation and Monitoring Program (Cenovus 2012). Mitigation for wildlife may include, but is not limited to, the following:

- Avoid clearing from March 1 through August 15 to avoid disturbing early nesting birds such as raptors, owls, and woodpeckers and bird species at risk. If clearing is necessary during this period, use qualified experts to conduct breeding, and nesting surveys for birds prior to clearing.
- Avoid clearing from May 1 through August 15 to avoid potential nesting of migratory birds, or conduct a survey to determine their presence, to meet the requirements of the Migratory Birds Convention Act.
- Avoid clearing during woodland caribou RAP (February 15 to July 15). If extenuating circumstances require clearing within the caribou RAP, enhanced caribou monitoring will be conducted within 500 m of the cleared area. If caribou are observed, the clearing activity will be suspended until the caribou leave.
- Maintain setbacks from water bodies for CPF expansion, SAGD well pads and disposal well pad, where practical;
- Allow regeneration of native vegetation in cut lines;
- Progressively reclaim corridors that are no longer required for the Project, to reduce habitat fragmentation; and
- Progressively reclaim Project disturbances.

8.1.2 Construction, Operations and Reclamation Guideline Documents

Cenovus intends to adhere to applicable regulatory guidelines, which include those listed in Table 8.1-1, and will adapt reclamation plans as guidelines change to follow the most current regulatory requirements at the time of reclamation.

Table 8.1-1 Applicable Reclamation Guideline Documents

Pertinent Construction and Reclamation Guideline Documents	Reference
2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (Updated June 2011)	AENV 2011b
Environmental Protection Guidelines for Electric Transmission Lines (R&R/11-03)	AENV 2011c
2010 Reclamation Criteria for Wellsites and Associated Facilities Application Guidelines.	AENV 2011d
Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition	AENV 2010a
Alberta Tier 1 Soil and Groundwater Remediation Guidelines	AENV 2010b
Alberta Tier 2 Soil and Groundwater Remediation Guidelines	AENV 2010c
Environmental Protection and Enhancement Act Conservation and Reclamation Regulation (AR 115/93, as amended)	AENV 2008b
Guideline for Wetland Establishment on Reclaimed Oil Sands Leases (2nd edition)	AENV 2008c
Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body	AENV 2006a
Code of Practice for Watercourse Crossings	AENV 2006b
Sites Reclaimed Using Natural Recovery Methods	AENV 2003
Environmental Protection Guidelines for Oil Production Sites (C&R/IL/02-1)	AENV 2002
Environmental Protection Guidelines for Roadways	AENV 2000
Conservation and Reclamation Guidelines for Alberta	AENV 1997
Reclamation Criteria for Wellsites and Associated Facilities - 1995 Update	AENV 1995
Guide for Pipelines Pursuant to the *Environmental Protection and Enhancement Act* (EPEA) and Regulations	AEP 1994a
Guide for Oil Production Sites: Pursuant to the EPEA and Regulations	AEP 1994b
Progressive Reclamation and Interim Clean-up (Directive No. 2010-02)	ASRD 2010b
Management of Wood Chips on Public Land (Directive 2009-01)	ASRD 2009
A Guide to Surface Material" Resource Extraction on Public Land	ASRD 2008
Forest and Prairie Protection Act Regulations, Parts 1 and 2 ; Timber Management Regulation	ASRD 2001
Drilling Waste Management (Directive 050)	ERCB 2012
Well Abandonment Guide (Directive 020)	ERCB 2010
Storage Requirements for the Upstream Petroleum Industry (Directive 055)	ERCB 2001
Oilfield Waste Management Requirements for the Upstream Petroleum Industry (Directive 058)	ERCB 1996a
Soil Monitoring Directive (2009)	Government of Alberta 2009
Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition	AENV 2010a

The 2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (2010 criteria) was released in 2010 and was updated in 2011. The 2010 criteria are "based on land function and operability that will support the production of goods and services consistent in quality and quantity with the surrounding landscape" (AENV 2011b). The 1995 Reclamation Criteria for Wellsites and Associated Facilities (AENV 1995) are the applicable criteria for assessment of reclamation in peatlands. Criteria for reclamation in peatlands are currently under review by the Reclamation Criteria Advisory Group (AENV 2011b).

8.1.3 Interim Reclamation

Reclamation is planned during all stages of the Project, including interim reclamation of facilities during Project operation. The pipeline and power line (utility) ROWs will be allowed to naturally revegetate after construction, where regrowth does not impede operations monitoring and the success of regeneration will be monitored. Areas in a utility ROW that do not revegetate within two years of soil replacement will be revegetated using native species (Section 8.4).

Other examples of interim reclamation measures might include:

- removing temporary water crossings (e.g., wood bridges, log fills, culverts, snow fills);
- seeding facility edge areas not needed for operations, where practical;
- managing brush along pipeline ROWs to allow access for surveillance, yet allow natural revegetation along the edges;
- reclaiming temporary workspace areas after construction is complete;
- revegetation of exposed cut slopes and stabilizing soil stockpiles.

Construction and reclamation activities, soil salvage volumes and stockpile locations will be documented in Cenovus's Annual Conservation and Reclamation Reports, which will be prepared and submitted to AESRD according to guidelines (AENV 2011e) and the EPEA Approval, as amended.

8.1.4 End Land Use Objectives

The main goal for the reclamation of upland sites will be to achieve reclaimed forest plant communities that integrate with the surrounding undisturbed areas. Project sites located in upland areas (mineral soil) will be reclaimed and revegetated with woody and herbaceous species that will correspond with the local area and the intended land use, including traditional use.

Due to the extent of Organic soils (peatlands) in the LSA, some facility sites will be located partly or wholly on Organic soils and will require pads constructed using borrow fill. The main reclamation goal in peatlands will be reclamation of SAGD well pads to wetland conditions that will support establishment of wetland vegetation. The reclaimed areas where pad materials will be removed are referred to as "reclaimed wetland" in this Reclamation Plan. Techniques are not currently available for reclamation of well pads in peatlands that will return these disturbances within a few years of reclamation to the pre-development conditions. However, it is anticipated that where fill is removed from padded sites in peatlands, the conditions in the reclaimed sites will support the growth of wetland species.

The closure target for the access roads is also to reclaimed wetland because the roadbed materials will be removed (Section 8.3.3.2). Pipeline and power line ROWs, which have minimal surface disturbance and do not require pads, will be reclaimed to conditions that are expected to be similar to pre-development conditions, in both uplands and peatlands.

At closure, the reclaimed Project areas are anticipated to support vegetation communities that will be consistent with the surroundings, except in bog peat, where the reclaimed wetland areas will support early colonizing wetland plants. Therefore, the reclaimed Project areas are expected to have the capability to support end land uses and wildlife habitat that will be similar, although not necessarily identical, to the land uses in the surrounding areas or those which existed prior to disturbance. By following the recommended reclamation techniques and proper replacement of salvaged soil horizons, it is expected that the reclaimed soils will sustain plant communities that will be equivalent, although not identical, to the surrounding undisturbed ecosites.

8.2 RECLAMATION OF LANDFORM AND DRAINAGE

Reclamation objectives for upland and wetland areas include reclaiming to soil, landform and drainage conditions that approximate the adjacent undisturbed areas. Reclamation of disturbances will be done to achieve drainage that is compatible with the surrounding land, avoid erosion and protect any nearby sensitive areas (e.g., water features). Landform and drainage of surface water will be re-established to integrate drainage with the watercourses in the surrounding areas, as presented on Figure 4.1-1.

The change in landforms for the Project from the Baseline Case to post reclamation will be negligible (Volume 5, Section 11, Terrain and Soils). The reclaimed landforms will be consistent with the surrounding landforms and are planned to include diversity of micro-topographic relief. There will be an increase in the extent of upland and organic terrain as Baseline Case disturbances are reclaimed to pre-disturbance conditions (Sections 8.1 and 8.3). Cenovus will also include wetland reclamation principles and design, where practicable, into its reclamation plans.

8.3 RECLAMATION MEASURES AND RECLAMATION MATERIAL BALANCE

8.3.1 Decommissioning and Abandonment

Individual facilities will be decommissioned and abandoned during all stages of the Project, when it is determined that a particular facility will no longer be required. At the end of the Project, remaining facilities will be decommissioned and abandoned. Six months before the Project ceases operation, Cenovus will apply for an amendment to the EPEA Approval by submitting a decommissioning plan and land reclamation plan to AESRD.

After decommissioning, Phase I Environmental Site Assessments (ESA) will be completed for production sites (AENV 2011d). Where necessary, potential impacts will be assessed in a Phase II ESA, with assessment of parameters completed according to *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Tier 1; AENV 2010b), as updated. Where required, remediation will be completed with the endpoints for applicable parameters based on remediation guidelines, as updated (AENV 2010b, 2010c). Assessment following remedial actions determines if the endpoints for applicable parameters have been achieved (AENV 2010b). After decommissioning and abandonment of facilities at a site, any remaining contamination, if any, will be addressed in compliance with the regulatory guidelines before reclamation work starts.

Infrastructure and concrete will be removed and disposed of appropriately, or, with the approval of AESRD, minor quantities of debris may be buried on-site. Production and monitoring wells will be abandoned in accordance with ERCB (ERCB 2010) standards. Culverts and other watercourse crossing structures will be removed from access roads before the roadbeds are reclaimed.

8.3.2 Reclamation of Mineral Upland Sites

8.3.2.1 Soil De-compaction and Erosion Management

High traffic areas will subject the subsoil grade to considerable loads during the Project life. The soil base in these areas will become compacted. To ensure adequate reclamation of high traffic areas, Cenovus will ensure that these areas are deep ripped.

The use of deep rippers or subsoiling cracks and loosens dense soil layers to allow for deeper root penetration into the subsoil (Sene et al. 1985; Vepraskas et al. 1987). Additional benefits may include reducing rooting restriction and oxygen stress, thereby increasing plant root utilization of subsoil (AENV 2011b). In trials conducted at reclaimed well sites and access roads in northern Alberta, McNabb (2011) observed positive responses of tree seedling growth following deep tillage using an experimental patented ripper with plowshares mounted on shanks. The use of a heavy disc after ripping might be required to break down chunks of subsoil before contouring commences.

The control measures discussed in Section 6.8.3 will be considered and applied on a case by case basis to control soil erosion and contain sediment during reclamation until protective vegetative cover is established. Greater attention will be given for erosion mitigation measures when soil handling and replacement activities occur with the salvaged sandy soil materials (i.e., Liza SMUs) and where moderate or strong slopes prevail (CPF expansion, Substation, and in Twp. 70, Rg. 6, W4M).

8.3.2.2 CPF, Access Roads and Well Pads

Reclamation of the CPF expansion, access roads, and all well pads on mineral soils will be done preferably under dry, unfrozen conditions, where practical.

Reclamation steps will generally include the following:

- removing salvageable surface gravel and reusing it elsewhere, where feasible;
- alleviation of compaction through deep ripping, with or without discing;

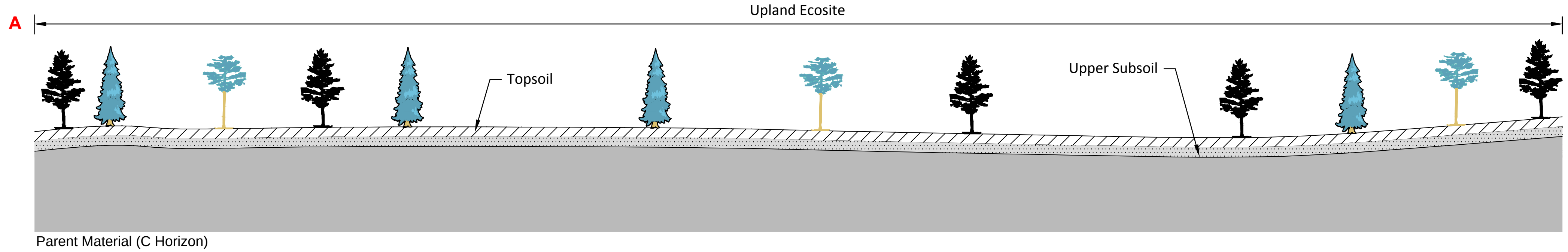
- removing berms and filling ditches to leave a stable surface;
- re-contouring for compatibility with surrounding landforms and drainage patterns;
- replacing salvaged upper subsoil, where applicable, and conditioning it as required;
- replacing salvaged surface soil materials;
- adding amendments (e.g., peat), if required;
- revegetating;
- monitoring (Section 8.7) to assess reclamation and identify deficiencies, if any; and
- undertaking additional reclamation measures, where required.

Construction and reclamation of a SAGD well pad in upland mineral soil is conceptually illustrated on Figure 8.3-1. After contouring to landforms and drainage contours that integrate with the surrounding areas, salvaged soil materials will be replaced. The reclamation drainage swales will be seeded with a native grass mixture to enhance vegetation establishment for erosion mitigation. Cenovus intends to have topsoil replaced to leave small ridges or mounds, with hollows or shallow depressions, and use scattered woody debris. If wet soil conditions or strong winds that cause soil drifting prevail during soil handling, soil replacement activities will be suspended to avoid soil quality degradation or soil loss. Compacted subsoil and topsoil will be alleviated appropriately.

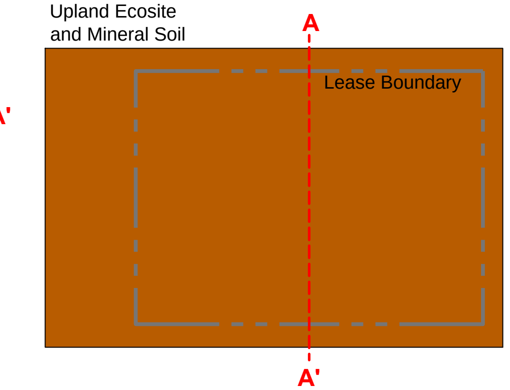
Available coarse woody debris will be spread on reclaimed land after soils are replaced. Woody debris has been reported to provide microsites for enhancing woody species establishment (Brown 2010). Research has found woody debris did not affect initial vegetation emergence, but it increased native species richness and decreased introduced species (Brown 2010). Survival of saplings planted where woody debris had been spread was greater than in areas without woody debris (Brown 2010).

Disturbances that will have minimal soil disturbance will not be disturbed further after decommissioning and removal of infrastructure. Rollback and available rocks could be placed at accessible points of reclaimed access and utility ROWs, after consultation with AESRD, and taking into consideration traditional use. Conceptual reclamation of an access road and adjacent pipeline and power line ROWs in upland mineral soil is presented on Figure 8.3-2.

ORIGINAL LANDSCAPE
WELLPAD BOUNDARY

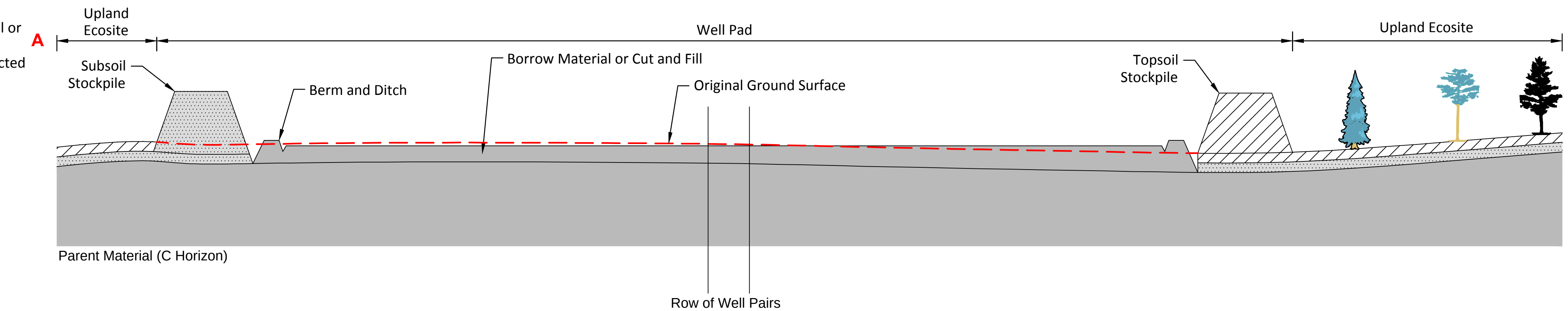


ORIGINAL LANDSCAPE
PLAN VIEW

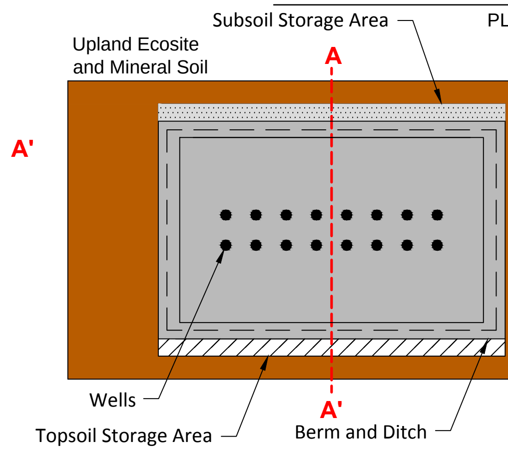


CONSTRUCTED WELL PAD
WELL PAD BOUNDARY

1. Salvage topsoil and upper subsoil and stockpile in the storage area.
2. Construct well pad using cut and fill or imported borrow material where required. (External ditches constructed where required.)
3. Place gravel on pad.

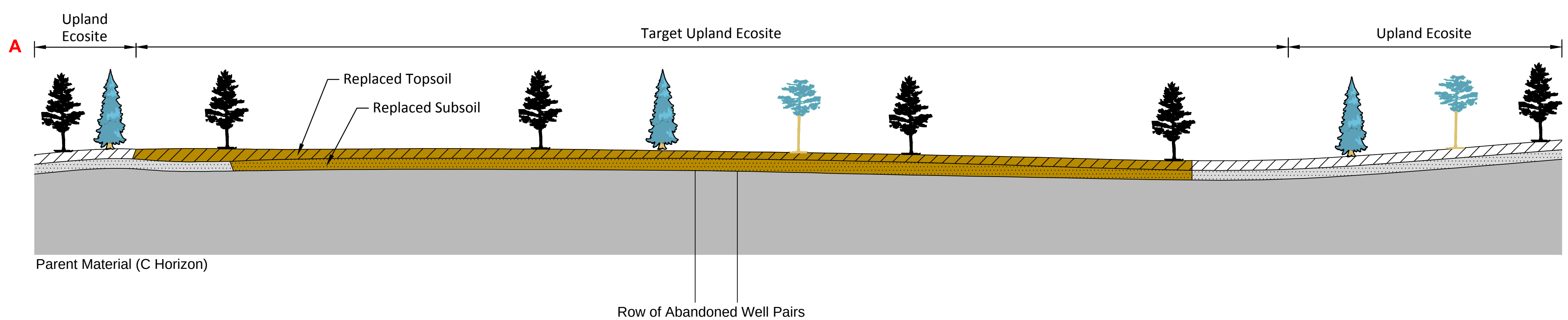


CONSTRUCTED PAD
PLAN VIEW

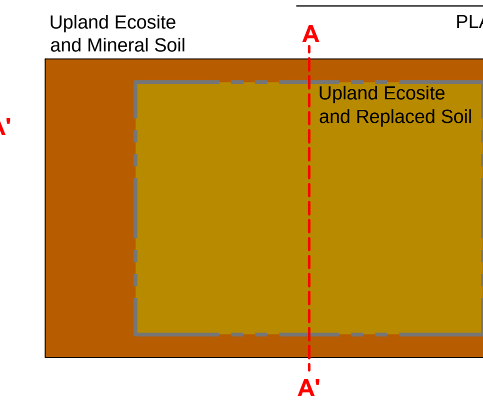


RECLAIMED WELL PAD
WELL PAD BOUNDARY

1. Abandon well with > 1.5 m cover, remove gravel.
2. Pad removal: decompact and recontour any borrow fill and subsoil.
3. Replace upper subsoil and topsoil.
4. Revegetate to target species.



RECLAIMED PAD
PLAN VIEW



LEGEND:
- Black Spruce
- Jack Pine
- Poplar

Reclaimed Map Unit
- Replaced Soil

Undisturbed Soil Layers
- Topsoil "A" Horizon
- Upper Subsoil "B" Horizon
- Parent Material "C" Horizon

Replaced Soil Layers
- Replaced Topsoil "A+LFH/O" Horizon
- Replaced Upper Subsoil "B" Horizon

Notes:
1. Not to scale.
2. Drawings are conceptual. Construction will be conducted according to engineering drawings.

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

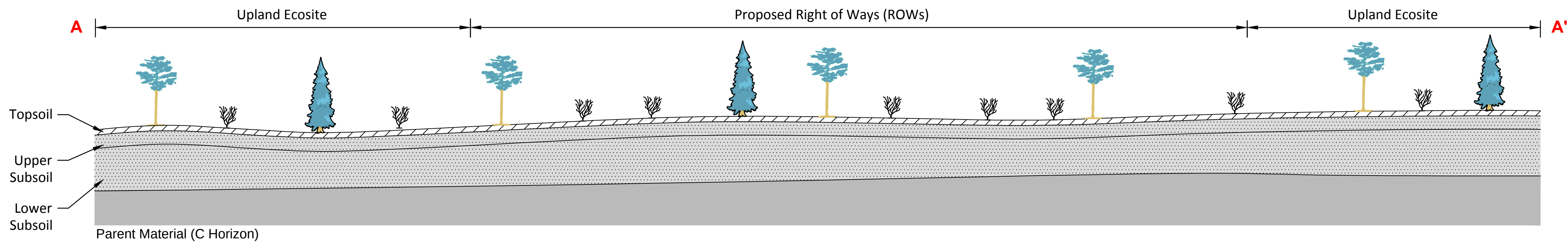
Conceptual Construction and Reclamation of Well Pad on Mineral Soil

Date:	Project:	Technical:	Reviewer:	Drawn:
November 2012	11029-CR-12	R. Labbe	B. McNaughtan	K. Cheng

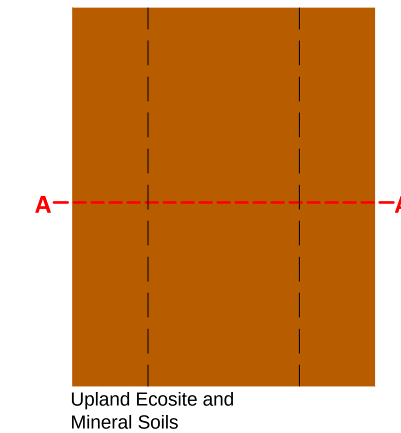
Figure 8.3-1

Plot 1:1 = Tabloid (L)
F:\11029\Drafting\2012\11029-CR-12.dwg - WellPad-Mineral-Fig_8.3-1 - Monday, January 14, 2013 1:45:52 PM - Kelvin Cheng

PRE-DISTURBANCE
CROSS-SECTION

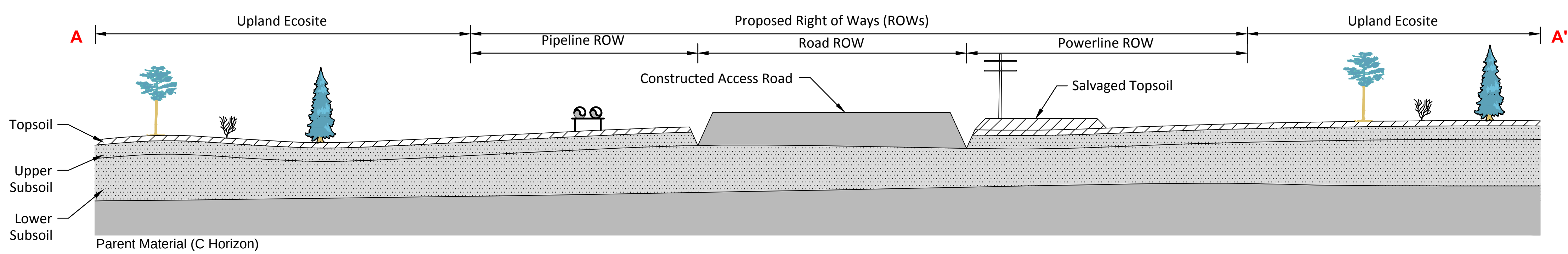


PRE-DISTURBANCE
PLAN VIEW

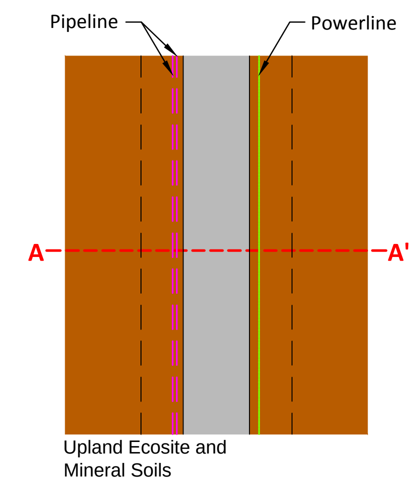


CONSTRUCTED
CROSS-SECTION

1. Vegetation cleared.
2. Topsoil materials salvaged from road and stored on outer ditch slope and powerline ROW.
3. Roadbed constructed using lower subsoil and C horizon, as appropriate.
4. Pipelines and powerlines constructed.
5. Gravel spread on top of road.

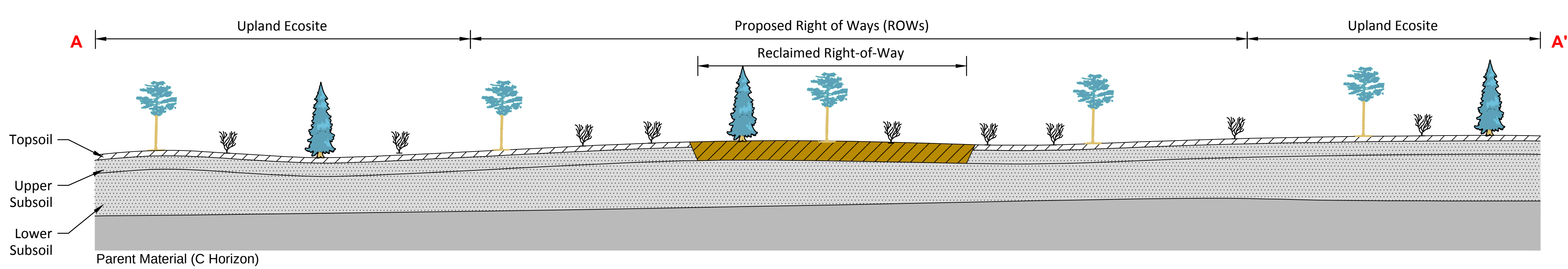


CONSTRUCTED
PLAN VIEW

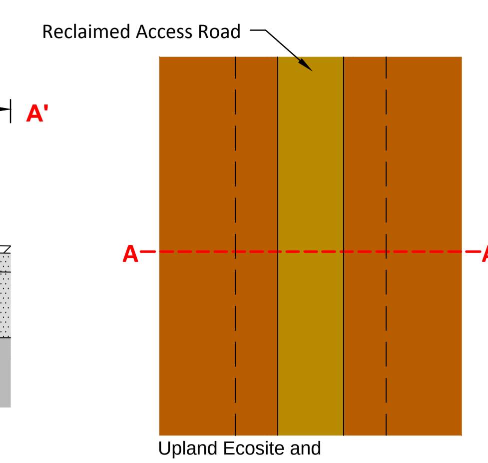


RECLAIMED
CROSS-SECTION

1. Pipelines and power line removed.
2. Remove gravel and reuse where practicable.
3. Roadbed ripped and recontoured, ditches filled.
4. Stored toposil replaced across recontoured road.
5. Revegetate ROW.



RECLAIMED
PLAN VIEW



LEGEND:
- Black Spruce
- Poplar
- Shrubs
- Aboveground Pipe and Pipe Rack
- Powerline

Reclaimed Map Unit
- Reclaimed Access Road

Undisturbed Soil Layers
- Topsoil "A" Horizon
- Upper Subsoil "B" Horizon
- Parent Material "C" Horizon

Replaced Soil Layers
- Replaced Topsoil "A+LFH/O" Horizon

Notes:
1. Not to scale.
2. Drawings are conceptual. Construction will be conducted according to engineering drawings.

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Conceptual Access, Pipeline and Powerline Corridor on Mineral Soil

Date:	Project:	Technical:	Reviewer:	Drawn:
November 2012	11029-CR-12	R. Labbe	B. McNaughtan	K. Cheng

Figure 8.3-2

8.3.2.3 Borrow Areas

Borrow areas will be reclaimed to upland landforms combined with low-lying areas, to establish a natural and stable landscape. Where the fill of a pad removed during reclamation is not reused, the fill will be returned to the closest borrow area. After a borrow excavation is refilled to an elevation consistent with the surrounding topography, it will be contoured to stable slopes with edges that blend in with the surrounding area. The reclaimed borrow areas will be revegetated to species compatible with the surrounding vegetation (Section 8.4).

Where a borrow area is not refilled and retains seasonal surface water, the borrow area will be reclaimed with gentle slopes with the objective of achieving shallow water depths to promote the growth of emergent vegetation. Flood tolerant grasses might be seeded along the margins to enhance revegetation and the development of marsh-like habitat, which would benefit marsh dependant species such as waterfowl. If surplus peat or topsoil materials are made available by reclamation of a borrow area to shallow water, the materials will be used as a surface amendment in the reclamation of existing disturbances in the Project footprint.

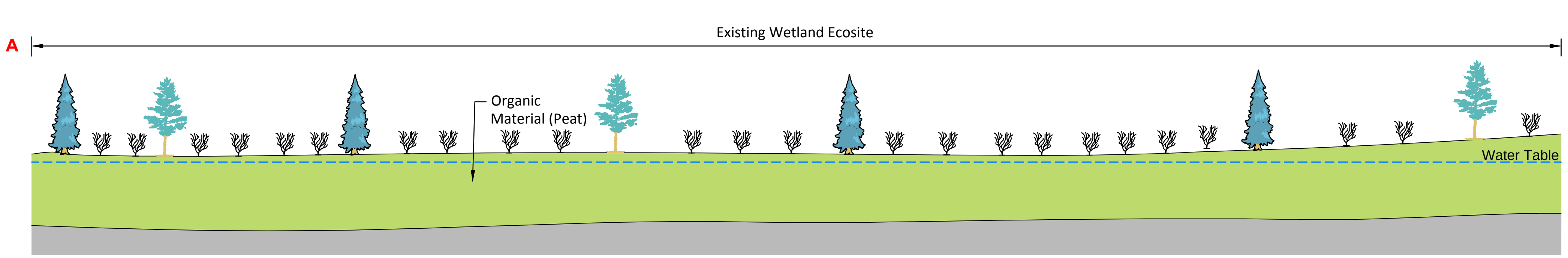
8.3.3 Reclamation of Peatland Sites

8.3.3.1 Well Pads

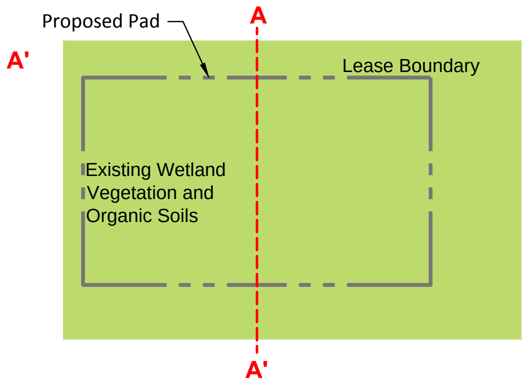
The reclamation goal in peatlands (Organic soil) will be to reclaim the padded sites to wetland conditions that will support the growth of native wetland species. The general reclamation method for a well pad in peatlands will involve removing fill to return the disturbance to a reclaimed wetland feature (Figure 8.3-3). At many reclaimed well pad locations in peatlands, the elevation of the water table is expected to be higher than the compressed peat where all pad materials will be removed, which will result in leaving areas of mainly open water. The degree of peat compression beneath well pads will depend on peat depth, peat composition and density, weight of a pad, and the materials used during construction before fill is placed. The creation of microsites by slightly mounding the depressed peat surface to potentially enhance natural regeneration will be considered on a site-specific basis.

An alternative for reclaiming well pads in peatlands, which will be considered on a site-specific basis, involves the partial removal of fill to a level that is slightly lower than the perched water table in the surrounding peatlands, to avoid leaving areas of shallow open water following reclamation. In research trials in northwest Alberta, the partial removal of pad fill to leave hydrological conditions suitable for the establishment of wetland vegetation has been tested (Vitt et al. 2012). Results from trials east of Peace River indicate that removal of fill to near the elevation of the water in adjacent deep peat leaves a wet or very moist mineral soil substrate that supports the growth of early colonizing, foundation species, such as sedges and willows. After five years of growth since reclamation, all of the test plots that had been transplanted with sedge plants have a nearly continuous cover of sedges, with or without amendments or fertilizer.

ORIGINAL LANDSCAPE
CROSS-SECTION

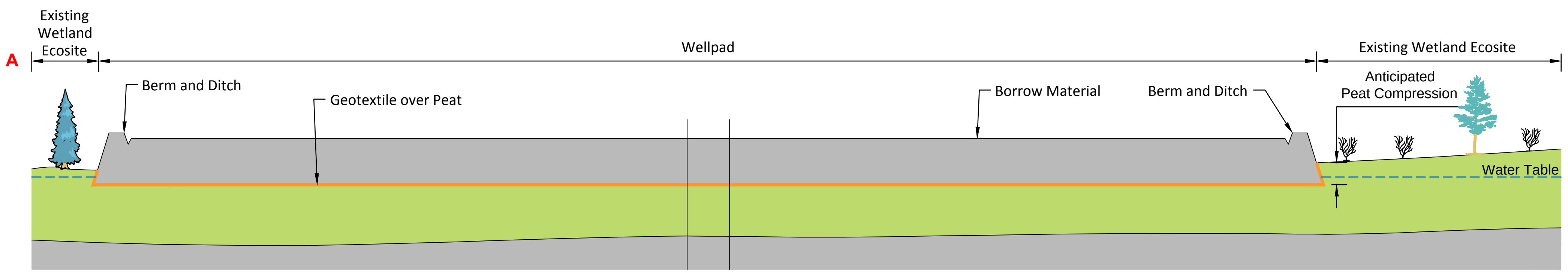


ORIGINAL LANDSCAPE
PLAN VIEW

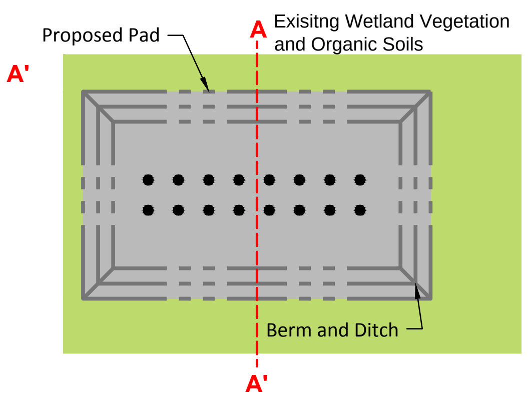


CONSTRUCTED PAD
CROSS-SECTION

1. Clear vegetation and potentially use woody debris as "corduroy".
2. Install geotextile over woody debris and peat.
3. Construct wellpad with borrow material.
4. Spread gravel on surface.

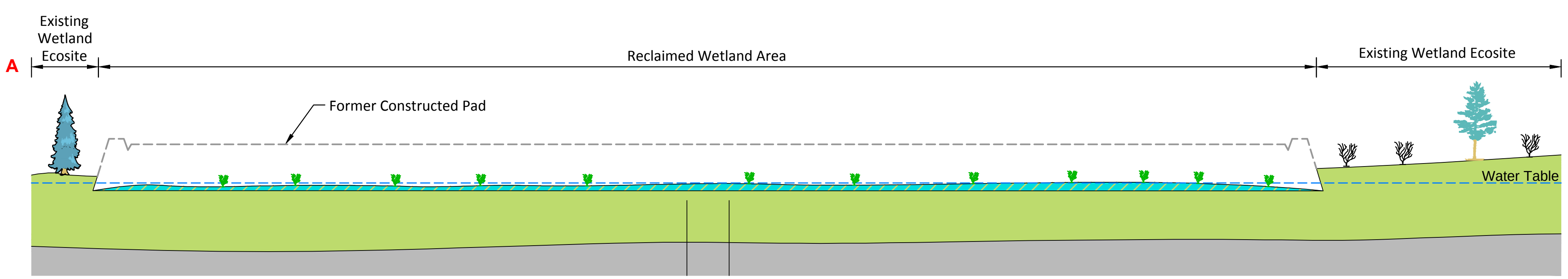


CONSTRUCTED PAD
PLAN VIEW

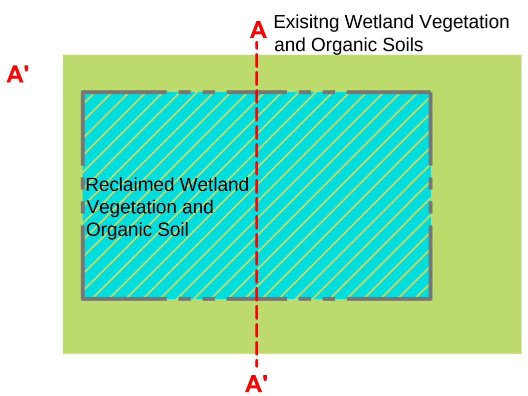


RECLAIMED PAD
CROSS-SECTION

1. Remove gravel and reuse if practicable.
2. Abandon wells.
3. Remove pad materials as per section 8.3.3.1, reuse pad material where practicable, or return to borrow pits.
4. Reclaimed area left to revegetate.



RECLAIMED PAD
PLAN VIEW



LEGEND:
- Black Spruce
- Tamarack
- Shrubs
- Sedge Grass

Reclaimed Wetland Area
- Reclaimed Wetland

Undisturbed Soil Layers
- Organic (Peat)
- Parent Material "C" Horizon

Notes:
1. Not to scale.
2. Drawings are conceptual. Construction will be conducted according to engineering drawings.

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Conceptual Construction and Reclamation of Well Pad in Peatlands

Date:	Project:	Technical:	Reviewer:	Drawn:
November 2012	11029-CR-12	R. Labbe	B. McNaughtan	K. Cheng

Figure 8.3-3

Reclamation of well pads in peatlands will be on a case-by-case basis, but will involve:

- excavating pad fill, after gravel salvage, to leave a poorly drained, wet lowland;
- reusing clean fill for construction or placing it in nearby borrow excavation(s); and
- revegetating with wetland species where practical (Section 8.4.2).

Extracted pad fill that is not reused will be returned to a borrow area with similar soil characteristics as the original borrow area, where practical. It may be appropriate to retain a portion of the pad fill for reclamation on a site-specific basis, particularly for reclamation of SAGD well pads situated in both peatlands and uplands (Section 8.3.4).

As experience is gained from the initial pad reclamations, Cenovus could modify reclamation procedures in the future. A procedure could include creating micro-hummocky surfaces where pad materials are removed to provide diverse micro-sites in reclaimed areas. The desired outcome of reclamation in peatlands is to leave a poorly to very poorly drained area that will sustain the growth of self-sustaining wetland vegetation. Planting of some early colonizing native wetland species will be considered for reclamation in peatlands.

An additional constraint to full removal of pad materials is related to well abandonment. In areas where the water table is at or slightly below the peat surface, the depth of well casing cut and cap procedures would be under water. These conditions will present safety hazards and constraints for well abandonment procedures to comply with the ERCB requirement that casings be a minimum of 2 m below the final reclaimed contour in peatlands (ERCB 2010).

8.3.3.2 Access and Utility Corridors

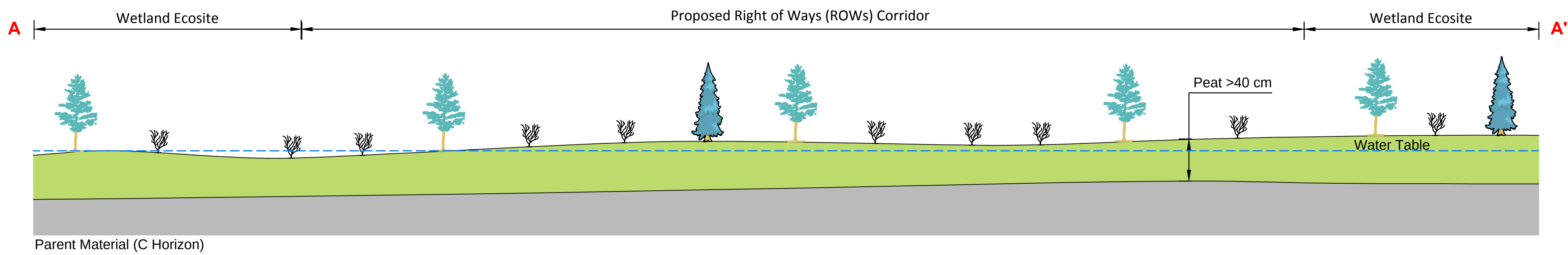
After power supply lines, aboveground pipelines and supporting structures are removed, revegetation of the small disturbance areas will be by natural regeneration. These small areas are anticipated to regenerate naturally to wetland vegetation and bryophytes.

After salvageable aggregate is removed from roadbed surfaces, the access roads in peatlands will be reclaimed by removing culverts, roadbed fill to below the adjacent water level and geotextile (Figure 8.3-4). Salvaged gravel and fill will be reused in construction, where practical. Revegetation is discussed in Section 8.4.

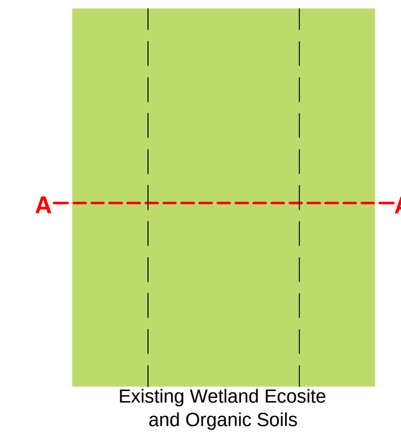
8.3.4 Reclamation of Sites Partly on Mineral Upland and Peatland

For the pad sites constructed partly in upland and partly in peatland, reclamation procedures for peatland will apply to the portion of the pad located in peatland. Pad fill will be removed from the margins adjacent to peatland to leave conditions that favour the growth of wetland vegetation. An area between the wetland side of a pad and the upland portion will be gently contoured to provide a transitional area between the two. Salvaged peat will be replaced in the wetland portions after the pad is re-contoured. Fill extracted from the wetland portion is typically used in contouring the upland side, and a portion of imported fill might be returned to a borrow area. Upland reclamation measures will apply to reclaim the portion of the well pad constructed on mineral soil.

PRE-DISTURBANCE
CROSS-SECTION

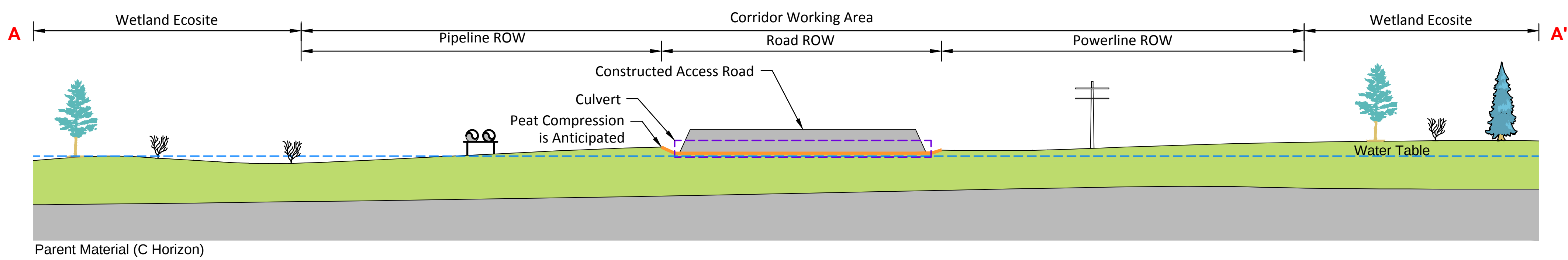


PRE-DISTURBANCE
PLAN VIEW

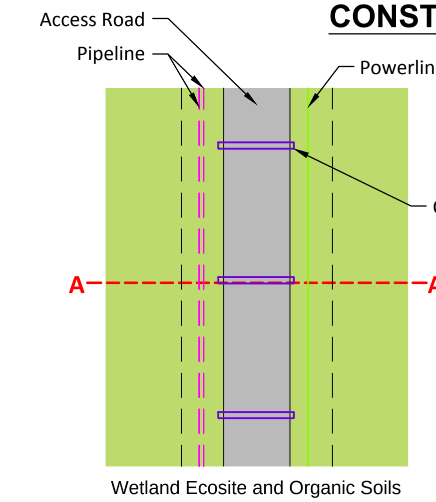


CONSTRUCTED
CROSS-SECTION

1. Vegetation cleared.
2. Corduroy/geotextile placed over peat across access road.
3. Culverts installed and recessed approximately one-third of their depth into the peat surface.
4. Access road constructed using borrow material; gravel spread on surface.
5. Aboveground pipelines installed.
6. Power lines installed.

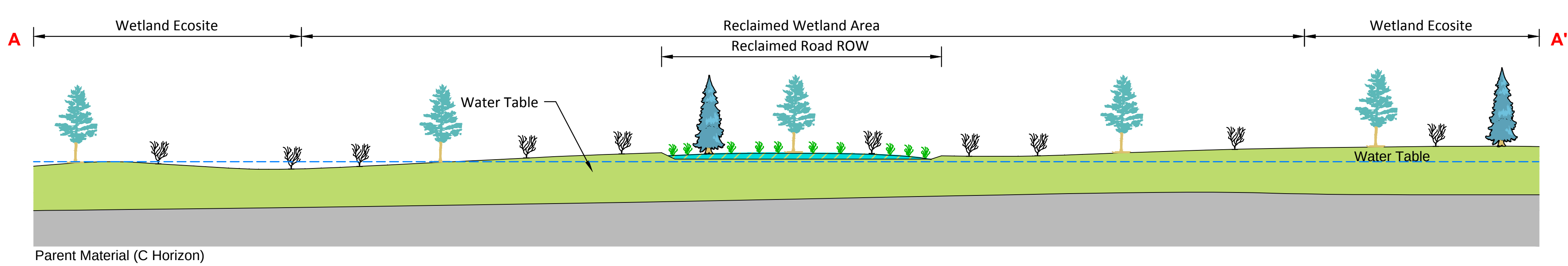


CONSTRUCTED
PLAN VIEW

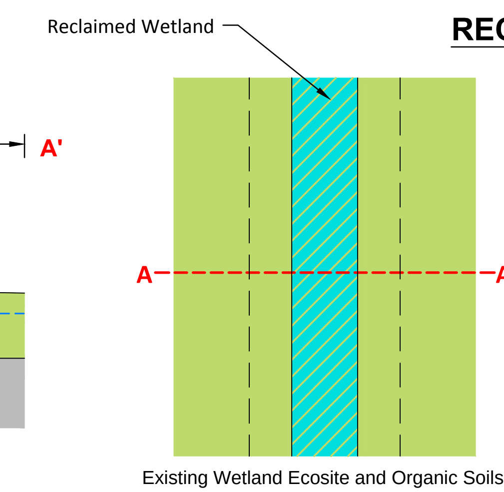


RECLAIMED
CROSS-SECTION

1. Pipelines and power lines removed.
2. Recover gravel where practical.
3. Culverts and associated fill removed from roadway.
4. Remove road fill as per section 8.3.3.2 and geotextile.
5. Reuse fill or return it to borrow areas.
6. Reclaimed ROW left to revegetate.



RECLAIMED
PLAN VIEW



LEGEND:
- Black Spruce
- Tamarack
- Shrubs
- Sedge Grass
- Aboveground Pipe and Pipe Rack
- Power Line

Reclaimed Wetland Area
- Reclaimed Wetland Area

Undisturbed Soil Layers
- Parent Material "C" Horizon
- Organic (Peat)

Notes:
1. Not to scale.
2. Drawings are conceptual. Construction will be conducted according to engineering drawings.

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Conceptual Access, Pipeline and Powerline Corridor in Peatlands

Date:	Project:	Technical:	Reviewer:	Drawn:
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Figure 8.3-4

8.3.5 Reclamation Materials Balance

Average horizon thicknesses were calculated from soil inspections in the Terrestrial LSA and were used to estimate reclamation material volumes. Average topsoil thicknesses of the soil map units were derived using the average topsoil thickness for each soil series to calculate a weighted average, based on the proportions of the soil series in each map unit (Table 4.2-1). Site-specific soil salvage depths will be identified in the PDA/C&R Plans of finalized site locations. The PDA/C&R Plans will include detailed reclamation material balances to a greater degree of confidence for individual facilities.

The average topsoil depths used to estimate the reclamation material balances are as follows:

- ABC-1 – 22 cm of LFH or shallow peat and mineral topsoil together;
- ABC-2 – 26 cm of LFH or shallow peat and mineral topsoil together;
- BLA-1 – salvage of shallow peat material from aaBMT and aaSTP components;
- aaBMT-1 – 27 cm of shallow peat, includes mineral topsoil horizon where present;
- aaBMT-2 – 28 cm of shallow peat, includes mineral topsoil horizon where present;
- LIZ-1– 20 cm of LFH/shallow peat and mineral topsoil together;
- LIZ-2– 23 cm of LFH/shallow peat and mineral topsoil together;
- MHL-1 – 23 cm of LFH/shallow peat and mineral topsoil together; and
- aaMUS – salvage of shallow peat material from the aaSTP component of SMU;
- SBN-1 – salvage of shallow peat material from the aaSTP component of SMU;
- SLN-1 – salvage of shallow peat material from the aaBMT and aaSTP components;
- SLN-2 – salvage of shallow peat material from the aaSTP component of SMU; and
- aaSTP-1 – 36 cm of shallow peat, includes mineral topsoil horizon where present.

The anticipated in situ volumes of topsoil materials to be salvaged and the estimated in situ volumes to be replaced at reclamation are presented in Table 8.3-1.

Table 8.3-1 Estimated Topsoil Reclamation Material Balance for the Project

Project Facility Type[1]	Area of Facility Type (ha)	LFH/Shallow Peat Topsoil Material[2] (m^3)	Deep Peat Material (m^3)	Total Surface Reclamation Material (m^3)	Topsoil Materials and Peat to be Replaced (m^3)	Balance (m^3)
CPF expansion	12	22,573	0	22,573	22,573	0
SAGD wellpads	289	481,976	0	481,976	481,976	0
Access Roads	169	227,400	0	227,400	227,400	0
Substation	9	12,123	0	12,123	12,123	0
Disposal Well	3	6,927	0	6,927	6,927	0
Borrow areas	158	338,424	123,123	461,547	461,547	0
Total		**1,089,423**	**123,123**	**1,212,546**	**1,212,546**	**0**

1. Above ground pipeline /power line soil salvage volumes are not included because minimal soil disturbance construction is assumed.
2. Estimated 15 cm of topsoil for existing disturbances, but topsoil depth will be assessed in site-specific pre-development assessments.

Although all salvaged soil materials will be replaced at the time of reclamation, soil handling and stockpiling is expected to modify physical soil properties. These changes are largely expressed by reduced soil material volumes at reclamation and generally greater bulk density of reclaimed soils compared to in situ soils, particularly for peat (Drozdowski et al. 2011; Leskiw and Zeleke 2011). The higher bulk density of reclaimed peat is the result of peat compression that occurs during soil salvage, stockpiling and replacement. During soil salvage, peat is dewatered and drying causes it to decrease in volume. During stockpile construction, the peat is trafficked by heavy equipment, which also compresses the peat. The aerobic decomposition of peat in a stockpile causes the peat to break down into fragments smaller than what is observed in the in situ peat (Drozdowski et al. 2011). Salvaged soil material is also trafficked by bulldozers during soil replacement, resulting in further compression.

Increases in bulk density of stockpiled peat and topsoil materials that include LFH are expected for the Project, which will translate into volumes that will be less than the estimated in situ volumes by approximately 80%. The final bulk densities of peat in reclaimed areas reported in the literature were determined to have no predicted limiting effect with respect to plant root penetration or water infiltration.

The estimated subsoil volumes to be salvaged and replaced are in Table 8.3-2. A subsoil thickness of 30 cm was used to estimate the reclamation materials, except for the Organic soil areas. No subsoil salvage was assumed for the Organic soil series (Birkland, Stebbing and St. Lina) because the peat is generally not salvaged and if it is salvaged, there is no B horizon subsoil to salvage. An average 30 cm of upper subsoil salvage was assumed for the mineral soils. The Gleysolic soils in Organic SMUs either lack a B horizon for salvage or the B horizon is too wet for soil salvage and handling.

Table 8.3-2 Estimated Subsoil Reclamation Material Balance for the Project

Project Facility Type	Area of Facility Type (ha)	Subsoil to be Salvaged (m^3)	Subsoil to be Replaced, by Facility Type (m^3)	Balance (m^3)
CPF expansion	12	33,828	33,828	0
SAGD wellpads	289	569,164	569,164	0
Access Roads	169	0	0	0
Substation	9	15,710	15,710	0
Disposal Well	3	9,278	9,278	0
Borrow areas	158	449,388	449,388	0
Total		**1,077,368**	**1,077,368**	**0**

1. Pipeline/power line soil salvage is not included, because minimal soil disturbance for power line and aboveground pipeline construction is assumed.

8.4 REVEGETATION PLAN

Reclamation will aim to restore self-sustaining vegetation communities that will be consistent with adjacent undisturbed vegetation and capable of supporting end land uses similar, but not necessarily identical, to pre-development. Revegetation plans will be developed to consider pre-disturbance information, surrounding vegetation, target landform and end land uses. By engaging CLFN, and in consultation with AESRD, Cenovus will endeavour to develop a revegetation plan that supports traditional land use.

8.4.1 Revegetation of Upland Mineral Sites

Seismic lines and winter access roads are expected to revegetate naturally due to their narrow width and minimal soil disturbance. These narrow vegetation disturbances will revegetate through natural ingress and from propagules in the soil and the root mat that will be left intact. If colonization in an area is slow or it is prone to erosion, the area will be seeded with an AESRD-approved mix, with additional erosion control treatment applied where required.

Disturbances in upland soil areas will be revegetated to forest species, with the target ecosite phases similar to the pre-development or adjacent ecosite phases. Planting prescriptions for the post-reclamation ecosites include commercial tree species as well as berry bushes and some peatland species. The planting prescriptions for uplands and transition areas based on surrounding ecosite phases are presented in Table 8.4-1 and include some traditional use species (e.g., alder, blueberry, bog cranberry, low-bush cranberry, raspberry, Saskatoon, willow).

Table 8.4-1 Planting Prescriptions for Upland Target Ecosite Types

Soil Moisture Regime	Planting Prescription Based on Surrounding Ecosite Phase	Tree Species(1)	Shrub Species (Density of 500 to 700 Stems per ha)
xeric, submesic	a1 lichen jack pine	jack pine	blueberry, bearberry, green alder
mesic to subxeric	b1 blueberry, jack pine-aspen	jack pine, aspen	blueberry, bearberry, Labrador tea
subxeric, submesic	b2 blueberry, aspen (white birch)	aspen, white birch, white spruce	blueberry, bearberry, Labrador tea, green alder
subxeric, submesic	b3 blueberry, aspen-white spruce	aspen, white spruce, white birch	blueberry, bearberry, Labrador tea, green alder
mesic to xeric	b4 blueberry, white spruce-jack pine	white spruce, jack pine	blueberry, bearberry, Labrador tea, green alder
mesic to subhygric	c1 Labrador tea (mesic), jack pine-black spruce	jack pine, black spruce	Labrador tea, green alder, bog cranberry, blueberry
mesic to subhygric	d1 low-bush cranberry, aspen	aspen, white spruce, balsam poplar, white birch	low-bush cranberry, Canada buffalo-berry, Saskatoon, green alder, rose, raspberry
mesic to subhygric	d2 low-bush cranberry, aspen-white spruce	aspen, white spruce, balsam poplar, white birch	low-bush cranberry, Canada buffalo-berry, Saskatoon, green alder, rose, raspberry
mesic, subhygric	d3 low-bush cranberry, white spruce	white spruce, aspen, balsam poplar, white birch	low-bush cranberry, Canada buffalo-berry, Saskatoon, green alder, rose, raspberry
mesic, subhygric	e1 dogwood, balsam-aspen	aspen, balsam poplar, white spruce, white birch	dogwood, low-bush cranberry, raspberry, green alder, rose

Table 8.4-1 Planting Prescriptions for Upland Target Ecosite Types (continued)

Soil Moisture Regime	Planting Prescription Based on Surrounding Ecosite Phase	Tree Species(1)	Shrub Species (Density of 500 to 700 Stems per ha)
mesic to hygric	e2 dogwood, balsam-white spruce	white spruce, aspen, balsam poplar, white birch	dogwood, low-bush cranberry, raspberry, green alder, rose
mesic to subhygric	e3 dogwood, white spruce	white spruce, aspen, balsam poplar, white birch	dogwood, low-bush cranberry, raspberry, green alder, rose
mesic to hygric	f1 horsetail, balsam-aspen	balsam poplar, aspen, birch, white spruce	rose, green alder, dogwood, raspberry, low-bush cranberry
mesic to hygric	f2 horsetail, balsam-white spruce	white spruce, aspen, balsam poplar, birch	rose, dogwood, low-bush cranberry
mesic to hygric	f3 horsetail, white spruce	white spruce	rose, low-bush cranberry
hygric, hydric, subhydric	g1 Labrador tea, black spruce-jack pine	black spruce, jack pine	Labrador tea, bog cranberry, blueberry
mesic to hydric	h1 Labrador tea/horsetail, white spruce-black spruce	black spruce, white birch, white spruce	Labrador tea, bog cranberry, willow
mesic to hydric	Shrubland	N/A	site-specific

(1) Tree planting densities can be determined using site type and desired end land use as indicated in Tables 4-5 to 4-14 in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010a).
N/A = not applicable

The species used to revegetate a site might be adjusted based on site-specific conditions. *The Guidelines for Reclamation to Forest Vegetation in the Alberta Oil Sands Region, 2nd Edition* (AENV 2010a), or updated version, will be used to group similar ecosites (through focusing on moisture and nutrient regimes) which will assist in the selection of appropriate species. The seeding of grasses that are highly competitive with woody seedlings will be avoided, except where there is a high erosion risk. Higher proportions of short-lived herbaceous species might be used in reclamation seed mixtures where colonization by adjacent native species is desired. After seeding and planting, regeneration of woody species is also expected from the viable plant propagules that might remain in replaced soil, although the viability of propagules will decline with time (AENV 201a; Mackenzie and Naeth 2009). A native grass seed mix for seeding of stockpiles in Table 6.5-1 may also be used in reclamation to enhance revegetation of bare areas. Forb species are prescribed for the establishment on reclaimed upland sites suitable for the CMNS (Table 8.4-2).

Table 8.4-2 Additional Candidate Herbaceous Native Species for the Central Mixedwood Natural Subregion

Plant Group	Common Name	Scientific Name
Forbs	Canada goldenrod	*Solidago canadensis*
	Cream-coloured peavine	*Lathyrus ochroleucus*
	Fireweed	*Epilobium angustifolium*
	Smooth fleabane	*Erigeron glabellus*
	Yarrow	*Achillea millefolium*
Grasses	Fringed brome	*Bromus ciliatus*
	Hairy wild rye	*Elymus innovatus*
	Mountain rice grass	*Oryzopsis asperifolia*
	Northern wheatgrass	*Agropyron dasystachyum*
	Purple oat grass	*Schizachne purpurascens*
	Slough grass	*Beckmania syzigachne*
	Spike trisetum	*Trisetum spicatum*

Revegetation to native herbaceous and woody species is expected to produce a relatively low fuel load (compared to unburned forest) for potential wildfire, in the early years following reclamation. Given the average annual burn area (Section 4.1.1), about 14% of the Terrestrial LSA could be affected by fire during the life of the Project until reclamation certification is achieved. However, it is very difficult to predict the effect of wildfire on revegetated sites, since fire activity is variable (Agee 1998; ASRD 2008b website) and weather dependant.

The vegetation on reclaimed mineral soils is expected to progress through succession to vegetation communities compatible with the adjacent ecosites. The target ecosites at closure are expected to contain similar types of vegetation as the pre-disturbance conditions.

8.4.2 Revegetation of Peatland Sites

Natural regeneration is the preferred option for revegetation of reclaimed access roads and well pads in peatlands. Natural revegetation of the reclaimed wetland area will mainly depend on the colonizing species in the adjacent undisturbed peatlands and the hydrological conditions. The progress of regeneration will be affected by the proximity of adjacent colonizing species. Shrubs and trees in one study had a high immigration potential onto peatlands because of their presence next to disturbances and the high dispersal ability of propagules (Campbell et al. 2003). Mosses also had a high potential to migrate onto milled peat bogs because of fecundity of the mosses and the dispersal of the spores by wind.

Where the water table will be higher than the surface of the reclaimed wetland area (mainly fen) after full removal of pad materials, areas of shallow open water are expected to develop with interspersed marsh vegetation. Establishment of wetland vegetation in the reclaimed areas might be enhanced by Cenovus by creating slight mounding of the peat surface, to promote establishment of different species (Graf 2008). Cenovus will consider the creation of microsites in these reclaimed wetland areas and will consider planting of wetland species to supplement natural regeneration, where practical.

Where fill of a well pad is removed to near the level of the water table, the transplantation of appropriate wetland species might be undertaken to enhance revegetation. Successful growth of early colonizing sedges with and without transplantation has been observed in trials east of Peace River, following the partial removal of fill to near the water level in adjacent deep peat (Vitt et al. 2012). After five years of growth since reclamation with or without surface amendments, the test plots in which sedges were transplanted have a nearly continuous cover of sedges. Plant matter then accumulates as it is slowly decomposed in the shallow flooded conditions. Primary peat accumulation is expected to develop in reclaimed wetland areas following the establishment of wetland vegetation and the accumulation of plant matter (AENV 2008c; Vitt et al. 2012). Bauer et al. (2003) indicated that initiation of present day peatland complexes in western Canada was largely the result of flooding of mineral soil with shallow water, rises in water tables and the development of graminoid wet fens or marshes, which initially produced a layer of slowly decomposing organic matter.

8.5 PROGRESSIVE RECLAMATION PLAN

Operational life of the Project is approximately 35 years. Reclamation will be undertaken throughout the life of the Project after facilities are decommissioned.

Examples of progressive reclamation measures include:

- spreading of ashes and woody debris left after burning across utility corridors;
- reclaiming and stabilizing disturbed stream banks by contouring, seeding with an AESRD-approved mixture and replacing woody debris; and
- reclaiming any new disturbance required during operations (e.g., spill clean-up).

Cenovus plans to progressively reclaim SAGD well pads and associated facilities when these have reached the end of their useful life, following abandonment and decommissioning. Reclamation of well pads brought into production during the initial six years might coincide with the construction of other SAGD well pads later in the life of the Project (Section 8.8).

Salvageable materials (gravel and fill) might be reused in construction where practical. Borrow areas will be progressively reclaimed by contouring, replacing salvaged topsoil and subsoil and revegetating the portions no longer in use as a source for fill (Section 8.3.2.3).

Additional reclamation measures will be undertaken at a Project site based on assessments from reclamation monitoring, to ensure the criteria of the day are satisfied. Monitoring after a site is reclaimed is discussed in Section 8.7.2. The information gathered during reclamation and monitoring will be used to modify future reclamation design, procedures and monitoring (adaptive management). Section 8.8 presents a projected timeline of progressive reclamation for the Project.

8.6 WATER FEATURES

There are no engineered water bodies associated with reclamation of the Project and there are no proposed "compensation" watercourses. Borrow areas will be primarily reclaimed to upland landforms that may include shallow water features which blend in with the surrounding landform. Detailed reclamation plans for borrow pits, including any reclaimed water features, will be developed to consider site-specific environmental conditions from pre-disturbance assessments, as required, and actual volumes of borrow material required for the Project.

8.7 MONITORING AND RESEARCH

Environmental monitoring for impacts that could affect land capability for forest ecosystems will be conducted throughout all stages of the Project. Reclaimed areas will be inspected after the first growing season following revegetation to assess initial vegetation establishment and to identify whether additional mitigation is required. Once vegetation is successfully established, progress toward the establishment of a diversity of vegetation communities consistent with wildlife habitat can be monitored over time.

Cenovus plans to be involved with regional monitoring (Section 7.3). Cenovus commits to monitoring ongoing reclamation research and development of the oil sands region. Cenovus also plans to modify future reclamation by adopting knowledge gained from external research on reclamation approaches/methods.

8.7.1 Construction and Operations Monitoring

The nature of the Project allows for sequential development and progressive reclamation of SAGD well pads and other sites as they are abandoned (Section 8.5). Environmental monitoring activities planned during Project construction and operations include:

- Construction activities will be monitored by qualified environmental personnel to ensure the environmental protection measures are followed.
- Watercourse crossing structures will be monitored and measures (e.g., clear blocked culverts) will be implemented to maintain water flow where required.
- Monitoring Project areas for prohibited noxious weeds and noxious weeds, as defined in the Weed Control Regulation (Alberta Regulation 19/2010).
- Areas where weed control measures are applied will be monitored to assess the effectiveness of weed control, where practical.
- Monitoring to evaluate the success of rare plant transplantation or reseeding will be used for future rare plant mitigation, as appropriate.
- If a substance release occurs, monitoring will be conducted following remediation, reclamation and revegetation of the associated disturbance.

Operations personnel will be responsible for monitoring of ditches, soil stockpiles and windrows for vegetation and signs of erosion. Deficiencies identified during monitoring will be mitigated, where practical. Monitoring activities will comply with EPEA Approval conditions, and Cenovus will respect all annual reporting requirements.

8.7.2 Reclamation Assessment

Environmental assessments of reclaimed sites will evaluate the parameters required in the reclamation criteria of the day, to document detailed soil, terrain and vegetation conditions. Information acquired on the reclamation of the upland sites and well pads in peatlands during the operations stage will contribute to adaptive management.

Reclamation criteria identify that the following parameters be satisfied to achieve reclamation certification:

- landscape characteristics (drainage, erosion, stability, contours, gravel and rocks, and debris) consistent with the surrounding areas to meet criteria;
- soil quality (e.g., texture, structure, consistence, compaction) and quantity (e.g., replaced topsoil depth) by field assessment methods;
- soils sampled to assess potential soil quality issues where required (AEP 1994b);
- adequate revegetation of disturbed areas with native woody and herbaceous species, and weed control.

Reclamation assessments will follow sampling procedures outlined in the reclamation criteria of the day. Vegetation will be assessed according to revegetation objectives, native plant species present, annual growth, ground cover, plant health and weeds. Any reclamation deficiencies will be assessed and where required, measures undertaken as needed to address any issues. After vegetation is established at a reclaimed disturbance site, the progress toward re-establishing the target, self-sustaining vegetation communities will be monitored. Once reclaimed sites meet the reclamation criteria of the day and the land use objectives, site assessments will be submitted with the applications for reclamation certificates.

8.7.3 Reclamation Uncertainties, Constraints and Alternatives

Predicting timelines for establishment of vegetation is more difficult than the timelines for soils and landform reclamation. It is anticipated that vegetation will require about two to five years to become established and to have suitable growth and species composition.

There is some uncertainty that remains concerning the time that will be required for peat accumulation following well pad reclamation, particularly for reclamation of sites on bog peat (AENV 2008c). Uncertainty originates from limited industry experience and limited early research on the reclamation of padded sites in peatlands, to return these areas to functioning peatlands similar to the pre-development conditions. There is also uncertainty regarding the effect of continued climate change on peat accumulation over the long term (AENV 2008c).

Results from other research trials on reclamation in peatlands are expected to become available during the life of the Project. Cenovus will investigate and incorporate into its plans new information on construction and reclamation techniques in peatlands, with the goal of mitigating potential environmental effects.

8.8 TIMELINE FOR COMPLETION OF DEVELOPMENT AND RECLAMATION

A projected timeline of development and reclamation is presented in Table 8.8-1. The timeline is approximate and is subject to modifications, in response to the receipt of regulatory approvals, business considerations, site conditions and weather.

Table 8.8-1 Development and Reclamation Schedule and Estimated Areas for the Project

Period	Project Footprint Facility Type	End of Period Estimated Incremental Disturbance Area (ha)	End of Period Estimated Incremental Reclamation Area (ha)
2015 to 2026	CPF expansion	12	0
	SAGD well pads	105	0
	Access roads, utility corridors[1]	300	0
	Substation	9	0
	Borrow area	78	0
	Disposal water well	3	0
	Subtotal for Period	***507***	***0***
2027 to 2039	CPF expansion	No new disturbance	0
	SAGD well pads	184	37
	Access roads, utility corridors[1]	204	25
	Substation	No new disturbance	0
	Borrow area	80	23
	Disposal water wells	No new disturbance	0
	Subtotal for Period	***468***	***85***
2040 to 2059	CPF expansion	No new disturbance	12
	SAGD well pads	No new disturbance	252
	Access roads, utility corridors[1]	No new disturbance	479
	Substation	No new disturbance	9
	Borrow area	No new disturbance	135
	Disposal water wells	No new disturbance	3
	Subtotal for Period	***0***	***890***
Total	**All facilities, end of Project**	**975**	**975**

[1.] Aboveground and power line rights-of-way are included within utility corridors.

End of production for the Project is projected to be 2053 and final reclamation will begin after decommissioning and environmental site assessments are done. Decommissioning and reclamation is discussed in Section 8.3.

Land reclamation might be completed within one year after decommissioning, after which assessments will be done to determine if additional reclamation is required. Some delays in completing reclamation might occur due to wildfire in dry years, or precipitation events in wet years that create wet soil for extended periods. Resumption of reclamation will occur when conditions are favourable again for soil handling.

The SAGD well pads initially reclaimed are expected to be ready for reclamation certification 12 to 20 years after initial pad production started. Final land reclamation activities at the Project are expected to begin in 2054 and could be completed by 2056. Vegetation assessments will be done three to five years later and Project closure could occur in 2059 to 2061, or later. Final reclamation and site closure could be delayed by remediation activities at a site, if required.

8.9 CLOSURE SCENARIO

8.9.1 Closure Scenario Ecosite Phases

Upland and wetland ecosite phases at closure (Table 8.9-1) were developed from the Baseline Case data using the end use objectives discussed in Section 8.1.

Table 8.9-1 Ecosite Phases and Disturbances in the Terrestrial Local Study Area at Closure

Land Cover	Baseline Case		Closure Scenario		
	Area (ha)	Percent (%)	Area (ha)	Change from Baseline Case	
				Area (ha)	Change (%)
Upland Ecosite Phases					
a1	389	3.2	390	1	0.2
b1	779	6.4	781	3	0.4
b1-regenerated blueberry jack pine-aspen	23	0.2	23	0	-0.3
b2	828	6.9	832	4	0.5
b3	406	3.4	411	5	1.1
b4	125	1.0	125	0	0.0
c1	1,468	12.2	1,473	5	0.4
d1	626	5.2	632	6	0.9
d2	677	5.6	680	4	0.6
d3	36	0.3	36	<1	0.3
e1	15	0.1	15	0	0.0
e2	2	0.0	2	0	0.0
f1	1	0.0	1	0	0.0
f2	27	0.2	27	0	0.0
g1	954	7.9	963	9	0.9
h1	2	0.0	2	<-1	-14.5
Upland Ecosite Phases Subtotal [1]	*6,357*	*52.8*	*6393*	*36*	*0.6*

Table 8.9-1 Ecosite Phases and Disturbances in the Terrestrial Local Study Area at Closure (continued)

Land Cover	Baseline Case		Closure Scenario		
	Area (ha)	Percent (%)	Area (ha)	Change from Baseline Case	
				Area (ha)	Change (%)
Wetland Ecosite Phases					
i1	225	1.9	212	-13	-5.7
i2	32	0.3	32	0	0.0
j1	3,286	27.2	3,137	-149	-4.5
j2	149	1.2	140	-9	-6.2
k1	367	3.0	355	-12	-3.3
k2	633	5.2	618	-15	-2.3
k3	38	0.3	37	<-1	-0.6
SR – shrubby riparian	24	0.2	24	<1	0.6
Reclaimed wetland (Section 8.3.3)	0	0	218	218	n/a
Wetland Ecosite Phases Subtotal [1]	***4,754***	***39.4***	***4,774***	***20***	***0.4***
Other					
AIG	4	0.0	4	0	0.0
AIH	16	0.1	16	<-1	-1.6
AII	155	1.3	154	<-1	-0.3
CIP	233	1.9	218	-15	-6.4
CIU	8	0.1	8	0	0.0
CIW	111	0.9	102	-9	-7.9
Hf	40	0.3	37	-3	-7.7
Hg	133	1.1	119	-14	-10.3
So	171	1.4	154	-16	-9.6
Other Anthropogenic Subtotal [1]	***870***	***7.2***	***812***	***-58***	***-6.6***
Water					
NWF – flooded	<1	<0.1	<1	0	0.0
NWL – lake, pond	88	0.7	88	0	0.0
NWR – river	7	0.1	7	0	0.0
Water Subtotal [1]	***95***	***0.8***	***95***	***0***	***0.0***
Total [1]	**12,075**	**100.0**	**12,075**	**0**	**n/a**

[1] Subtotal and total values might not equal the sum of the individual values, due to rounding.
n/a: not applicable

The closure scenario for vegetation is assumed to extend 80 years beyond the life of the Project. Reductions from the Baseline Case in the area of some of the wetland ecosite phases at closure reflect reclamation of the well pads and access roads in wetlands to the reclaimed wetland areas, as discussed in Section 8.3.3. Reductions from the Baseline Case in the extent of disturbed areas result from reclamation of these disturbances to similar target ecosite phases as pre-baseline. This results in small increases from the Baseline Case in the areas of some upland ecosite phases at closure. The distribution of ecosite phases in the LSA at closure is presented on Figure 8.9-1. The Vegetation assessment at closure is described in Volume 5, Section 12, Vegetation.

8.9.2 Closure Scenario Land Capability

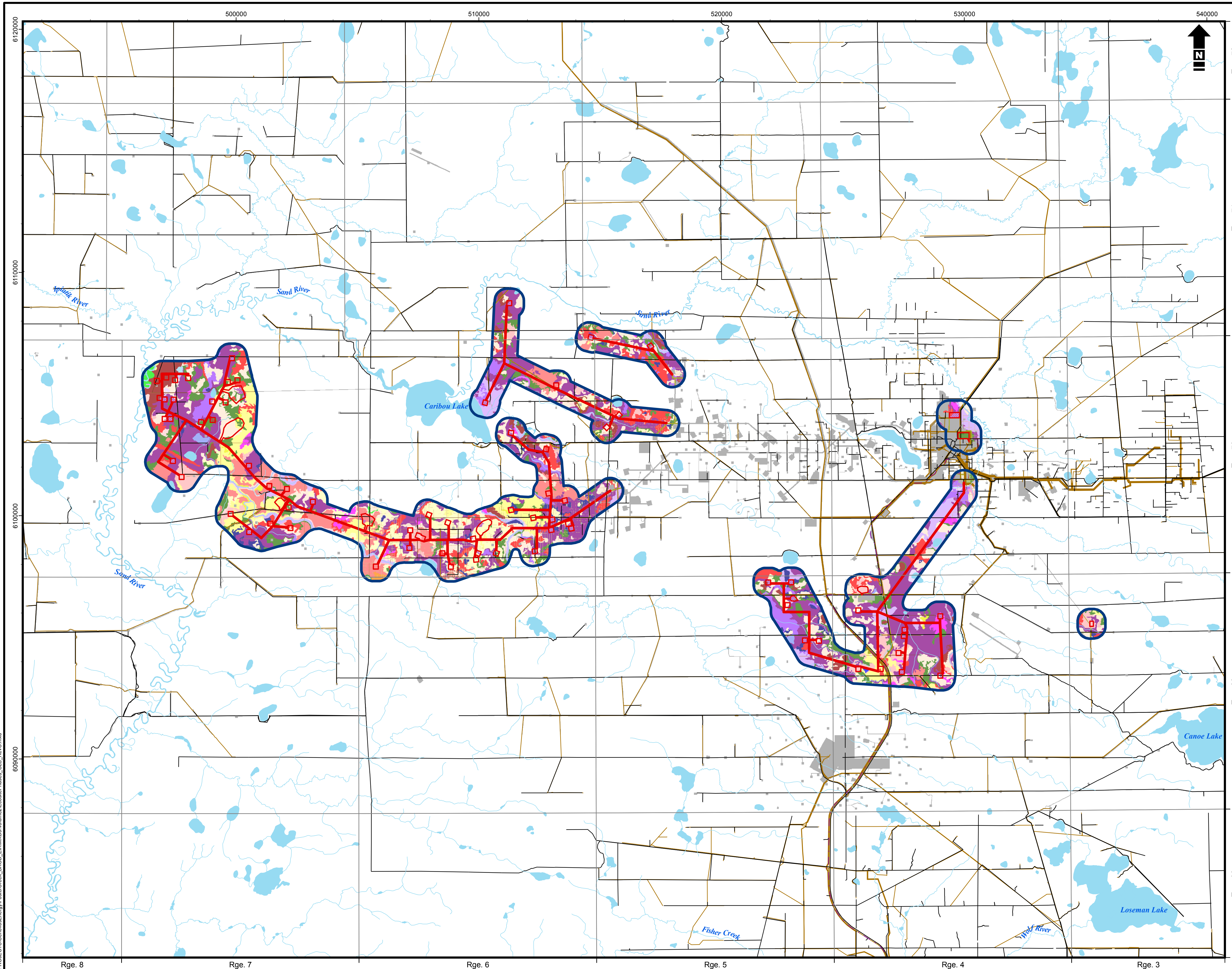
The Project disturbances will be reclaimed to lands with LCCS classes equivalent to the surrounding or adjacent undisturbed areas. The LCCS for forest ecosystems classes at the Baseline Case and the closure scenario are summarized in Table 8.9-2 and shown on Figure 8.9-2.

Table 8.9-2 Predicted Changes in Land Capability for Forest Ecosystems in the Terrestrial Local Study Area Following Reclamation

Forest Ecosystems Land Capability Class	Baseline Case		Post-Reclamation Closure Scenario		Change at Closure Due to the Project[1]	
	Area (ha)	% of LSA	Area (ha)	% of LSA	Area (ha)	% of LSA
class1 and class 2	0	0	0	0	0	0
class 3 (low)	3,305	27.3	3,317	27.5	12	0.2
class 4 (conditionally productive)	3,616	30.0	3,625	30.0	7	<0.1
class 5 (non-productive)	4,117	34.1	4,124	34.2	7	<0.1
unclassified (disturbance, all other)	1,037	8.6	1,008	8.3	-29	-0.3
Total [2]	**12,075**	**100.0**	**12,075**	**100.0**		

1. Change at closure is calculated as the difference between the Baseline Case and the Closure Scenario.
2. Total value might not equal the sum or difference of the individual values, due to rounding.

The LCCS class 5 (non-productive) is predicted for the reclaimed well pads and access roads in peatlands and in STP SMUs at closure, based on the targeted hydric to subhydric soil moisture regime after removal of well pads and access roads. Poor to very poor drainage and prolonged wetness will be the main capability limitations for forestry of the reclaimed wetland areas. The limitation is anticipated to result from equilibration of reclaimed wetland areas with the shallow water that is prevalent in peatlands. A minimal increase in the areas of each of LCCS Classes 3, 4 and 5 is the result of reclamation of existing soil disturbances in the Project footprint at the Baseline Case to similar LCCS classes as pre-baseline. This results in a corresponding reduction in the area of unclassified from the Baseline Case.



Project Footprint
Terrestrial LSA
Water Body
Watercourse
Road
Pipeline
Powerline
Anthropogenic Disturbance

Vegetated Disturbance

CIP - pipeline / transmission line
CIU
HF - herbaceous forb
HG - herbaceous graminoid
SO - open shrub

Ecosite Phases

a1 - lichen Pj
b1 - blueberry Pj-Aw
b1 - regen
b2 - blueberry Aw (Bw)
b3 - blueberry Aw-Sw
b4 - blueberry Sw-Pj
c1 - Labrador tea-mesic Pj-Sb
d1 - low-bush cranberry Aw
d2 - low-bush cranberry Aw-Sw
d3 - low-bush cranberry Sw
e1 - dogwood Pb-Aw
e2 - dogwood Pb-Sw
f1 - horsetail Pb-Aw
f2 - horsetail Pb-Sw
g1 - Labrador tea-subhygric Sb-Pj
h1 - Labrador tea/horsetail Sw-Sb
i1 - treed bog
i2 - shrubby bog
j1 - treed poor fen
j2 - shrubby poor fen
k1 - treed rich fen
k2 - shrubby rich fen
k3 - graminoid rich fen
Reclaimed Wetland
SR - shrubby riparian

Reference:
Data obtained from; AltaLis, Altus, IHS. Used under license.

1:150,000

4 0 4
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

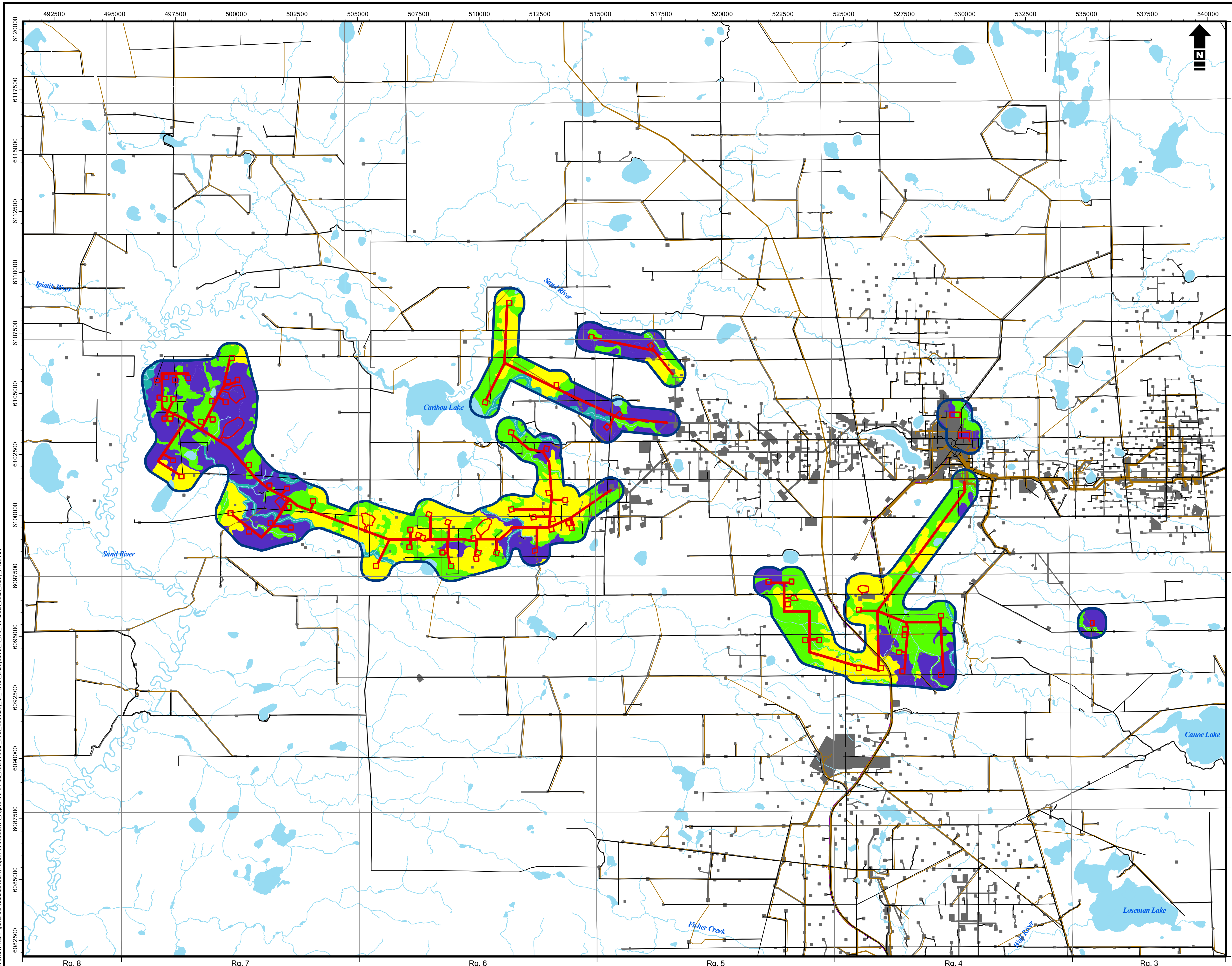
Foster Creek Thermal Project Phase J Expansion

Distribution of Ecosite Phases in the Terrestrial LSA at Closure

Date: 19 Feb 2013	Project: 307074-00146	
Technical: J.Lemire	Reviewer: M.Moss	Drawn: T.Graham

Figure 8.9-1

N:\PROJECTS\CenovusEnergy\FosterCreek_SAGD_EIA\MXDs\Volume2\EcositePhases_CLS_RevC.mxd



- Project Footprint
- Terrestrial LSA
- Soils Baseline Disturbance
- Water Body
- Watercourse
- Road
- Pipeline
- Powerline

Land Capability Class

- 3 (Low)
- 4 (Conditional)
- 5 (Non-Productive)
- Not Rated

Reference:
Data obtained from AltaLIS, Altus and IHS. Used under license.

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4 0 4
Kilometres

NAD 1983 UTM Zone 12N

cenovus ENERGY

Foster Creek Thermal Project Phase J Expansion

Post Reclamation Land Capability for Forest Ecosystems in the Terrestrial Local Study Area

Date: 20 Feb 2013	Project: 11029-514	
Technical: R.Labbé	Reviewer: B.McNaughtan	Drawn: K.Andruchow

Figure 8.9-2

8.9.3 Heterogeneity and Habitat Fragmentation Mitigation

By following the reclamation techniques recommended in this Reclamation Plan, it is expected that the reclaimed disturbances will support plant communities capable of ecological succession that will be equivalent, but possibly not identical, to the surrounding areas. Negligible changes in the abundance and distribution (heterogeneity) of the types of vegetation in the Terrestrial LSA are predicted at closure, as a result of reclamation. The biodiversity potential of the reclaimed sites in peatlands is expected to be similar to the pre-development potential. Habitat fragmentation, from existing and Project related linear disturbances, is expected to be reduced as reclamation of sites is completed. As regeneration of native vegetation and as succession progresses, connectivity among the remaining undisturbed patches is anticipated to be gradually restored; hence, fragmentation will decrease post-reclamation as the maturity of revegetated sites increases.

8.9.4 Wildlife, Biodiversity and Traditional Use

Cenovus will reclaim all disturbance areas in the Project footprint to upland forest and wetland conditions and vegetation that is compatible with the adjacent surrounding areas. The configuration (heterogeneity) of forest and wetland landscape types will change negligibly from the Baseline Case to the closure scenario because of the reclamation of existing soil disturbances (29 ha) in the Project footprint.

The Reclamation Plan contains measures to conserve biophysical resources for current land uses. It also aims to reclaim Project disturbances to landform and soil conditions that will support self-sustaining communities with wildlife habitat and vegetation species similar, but not identical, to pre-development conditions. Based on the Reclamation Plan, the reclaimed footprint is expected to support traditional land use. Cenovus will work with local stakeholders and endeavour to develop reclamation strategies that support traditional land uses.

8.10 PROGRESSIVE RECLAMATION MATERIALS HANDLING

The procedures for soil salvage and handling presented in Section 6.4 will also apply during progressive reclamation, except that soil storage will be short-term in a stockpile area until it is moved and spread across a reclamation site in upland mineral soil. The volume of soil materials and the receiving reclamation site will be documented and reported in the annual Conservation and Reclamation Reports for the Project.

8.11 RECLAMATION MATERIAL STORAGE

The topsoil materials from access roads will be spread along the access ROW ditches and onto the adjacent power line ROW, which will be on the opposite side of the road than the steam and production pipelines (Figures 8.3-2 and 8.3-4), to minimize contamination potential. Stockpiles of salvaged soil materials stored long-term at other production facilities will be located on stable ground at the site of origin, out of the way of production operations. Additional discussion of stockpile management is in Section 6.5.

8.12 RUNOFF AND WASTEWATER

Runoff that collects on-site during reclamation will be tested to ensure it meets the criteria of the EPEA Approval before being released off-site. Runoff water will be released in a manner that will prevent erosion or impacts to the surrounding area, after obtaining a Temporary Diversion License under the Water Act.

No industrial or process wastewater will be associated with reclamation activities.

8.13 SPILL RESPONSE AND WASTE MANAGEMENT

The potential for spills and wastes generation exists during the reclamation phase. Cenovus's procedures are discussed in Section 6.8.1. The appropriate Regulators will be notified of reportable spills according to the applicable legislation and regulations.

Wastes will be handled, contained, managed and disposed of according to the appropriate regulatory requirements. Liquid and non-solid wastes that are unsuitable for disposal in a Class II landfill will be taken to an appropriate approved facility for disposal. Reclamation waste and domestic waste will be hauled to the nearest approved landfill.

8.14 DUST, ODOUR AND NOISE MANAGEMENT

Dust management will be done by application of fresh water; appropriate authorization for the use of the water will be obtained. Odour and noise are not expected to be issues that will require specific management during the reclamation stage.

8.15 ENVIRONMENTAL MONITORING DURING RECLAMATION

Infrastructure specifically for reclamation will not be required. During final reclamation, monitoring wells will be abandoned as discussed in Section 8.3.1. Reclamation monitoring is discussed in Section 8.7.

8.16 STAKEHOLDER INVOLVEMENT

A primary Cenovus goal is to involve stakeholders and Aboriginal communities in a meaningful way in decisions that potentially affect them. Cenovus will work with local stakeholders and CLFN throughout Project reclamation activities, and endeavour to develop reclamation strategies that support traditional land uses. Cenovus will consult with AESRD throughout the life of the Project regarding reclamation targets and methods as appropriate.

8.17 CONTACT INFORMATION

Questions regarding reclamation can be directed to the following:

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