Vegetation and Wetlands Resource Assessment Report For the Connacher Oil and Gas Limited – Great Divide SAGD Expansion Project

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Prepared for

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DISCLAIMER

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EXECUTIVE SUMMARY

Connacher Oil and Gas Limited. (Connacher) is proposing to expand operations at their existing steam assisted gravity drainage (SAGD) facilities located approximately 70 km southeast of the community of Ft. McMurray in north eastern Alberta. This report addresses the proposed expansion ("the Project") and provides baseline information regarding terrestrial and wetland vegetation along with the baseline case biodiversity and habitat fragmentation conditions. In addition to the determination of baseline conditions, this report includes an assessment of the Project Application case and a Planned Development case (cumulative effects) to identify potential Project environmental effects on vegetation and wetland resources. Following review and consultation six valued environmental components (VECs) were identified and incorporated into the assessment; (1) Terrestrial Vegetation, (2) Wetlands including peatlands, (3) Old Growth Forests, (4) Non-native and invasive species, (5) Traditionally Used Plants, (6) Biodiversity.

A total of 216 field plots were established between 2006 and 2009 for vegetation mapping and assessment. Potential effects on VECs were assessed after accounting for relevant mitigation measures. In determining the significance of each effect, the magnitude of the effect, its geographic extent, duration, frequency, and ability for recovery from the impact was considered. All of the VECs were found to be insignificant with mitigation and monitoring.

Mitigation:

- developing revegetation plans that will promote the long term establishment of healthy ecosystems and ingress of native species;
- preserving adjacent habitat by minimizing the area required for construction and operation of the Project;
- stockpiled topsoil should be seeded with suitable species mix to ensure long term stability of the piles reducing erosion and the potential for weed establishment;
- when available, coarse woody debris should be used to amend soils to provide mycorrhizal and microbial inoculum;
- re-vegetation will be conducted according to the reclamation guidelines prepared by the Oil Sands Vegetation Reclamation Committee (OSVRC, 1998), CEMA, or updates;
- reporting the findings of rare and unranked species to ANHIC for updating provincial All Element Lists;
- placing rare species voucher specimens in a herbarium;
- select areas will be planted with pine and white and black spruce seedlings 2 to 4 years after seeding reclaimed lands;
- where possible, planting of aspen and white spruce should be used to increase the diversity of ecosite phases, versus the standard planting of mainly pine;
- accepted construction and reclamation practices should be used to maintain drainage patterns and preserve the integrity of wetland areas outside the Project footprint;
- create wetland "transition areas" between reclaimed sites and natural uplands and wetlands;
- remove fill material placed over organics to reestablish wetlands;

- reclaim borrow areas to wetlands, where possible;
- utilize opportunities to direct place peat materials from peatland areas scheduled for development to provide a living peat substrate and a propagule source for wetland vegetation;
- where suitable, introducing woody species typical of b1, b2, c1, d1, and g1 ecosite phases;
- during reclamation use recommended techniques and species that will limit the establishment and spread of non-native and invasive species (AENV 2008; OSVRC 1998);
- Aboriginal communities should be invited to participate in mitigation and monitoring recommendations and implementation to lend TEK that will compliment reclamation efforts;
- Connacher should determine alternative sources of traditionally used plants;
- areas with high biodiversity should be identified and the surface soil should be considered for soil salvage and use in direct placement reclamation;
- an adaptive reclamation strategy should be implemented to take advantage of opportunities present on the post-development contoured lands for establishment of a variety of plant communities (ecosite phases);
- use native shrubs (willow, berry species) and deciduous trees (aspen) where possible to provide structural diversity to the reclaimed stands as well as browse for wildlife; and,
- in areas where there is poor survival of seedlings, fill planting should be performed if target stocking densities are in jeopardy.

Monitoring:

- monitor reclaimed sites to assess the development of healthy ecosystems that will support natural vegetation capable of ecological succession;
- performing survival, growth and health assessments to monitor the success of revegetation efforts;
- conducting a rare plant survey on any new development areas not included in this assessment;
- monitoring and maintenance of drainage control structures should be conducted regularly to ensure water flow and flow patterns are maintained in wetlands adjacent to the PF during the construction, operation, and closure phases of the Project;
- monitoring of reclaimed wetlands should continue after closure to ensure healthy wetlands are being created;
- ensure regular site inspections during the life of the Project (construction, operation and closure) to identify if invasive species are becoming established;
- control any weed populations that are identified during monitoring; and
- assess the success of weed control activities;
- follow-up with Aboriginal communities as recommended during the consultation process; and,
- post reclamation surveys should be completed on sites reclaimed early in the life of the Project to assess success and allow for adaptive management of subsequent stages of reclamation.

Table of Contents

List of Tables

List of Figures

List of Appendices

1 INTRODUCTION

1.1 Content

This report has been prepared for Connacher Oil and Gas Limited (Connacher), for their proposed expansion to existing operations in the Athabasca oil sands lease (OSL) areas as outlined in Section 1.2.1 ("the Project"). This report provides information regarding terrestrial, riparian, and wetland vegetation as well as the biodiversity and habitat fragmentation conditions. Baseline data and information were gathered to investigate and document the existing plant species, vegetation types and other key characteristics of vegetation including species richness, abundance, and diversity. Baseline case inventories identified rare plant species and rare plant communities on a local scale, and captured the existing levels of biodiversity and habitat fragmentation on local and regional scales.

The baseline case provides context for the environmental assessment (EA) by identifying the potential effects of the Project on vegetation, wetlands, biodiversity, and habitat fragmentation.

Following the reporting of baseline conditions, Project-specific environmental effects on vegetation and wetland resources have been examined and assessed. Recommendations are made on measures to be used to mitigate, prevent, monitor, or reclaim those effects. Potential environmental effects on biodiversity and fragmentation of vegetation types and wetland resources are also assessed. Cumulative effects on vegetation and wetland resources, in addition to options for mitigation and monitoring plans, are considered.

Key indicators and the methods used in the assessment are presented in Section 2. Section 3 presents an overview of the vegetation and wetland resources including the study objectives and results of previous studies. Methods and results of the baseline vegetation and wetland assessment are presented in Section 4. The results of the baseline vegetation and wetland survey are found in Section 5. Section 6 details the assessment of Project environmental effects on both the local and regional study areas, and the effects on valued environmental components (VECs). Specific mitigation and monitoring recommendations are presented in Section 7. To address the specific expected outcomes defined in the Project Final Terms of Reference (FTOR; Alberta Environment 2009), a concordance table that cross references the FTOR with sections of this report is presented in Appendix 1.

1.2 Background

Since 2004, Connacher has been actively conducting exploration programs to delineate bitumen resources on its oil sands leases. Connacher currently operates in discrete areas within the lease areas that are suitable for economic development, using the Steam Assisted Gravity Drainage (SAGD) process. SAGD is a process used to extract bitumen at great depths (Connacher 2005). SAGD development effects on vegetation are primarily due to vegetation removal/clearing resulting from the construction of roads, well pads, and associated facilities and staging areas connected with project development.

1.2.1 The Project

The Project consists of the expansion of two existing developments within the Connacher oil sands leases. The first existing development, known as the Great Divide Pod One SAGD project (Pod One), is located in Sections 16 and 21, Township 82, Range 12, west of the 4th Meridian. Pod One is currently operational and received development approval from the ERCB in 2006. The second existing development area is the Great Divide Algar SAGD project (Algar), which is located 8 km east of Pod One, in Sections 18 and 19, Township 82, Range 11, west of the 4th Meridian. Algar received ERCB development approval in 2008. Pod One and Algar together occupy 218 ha.

The Project as outlined in this report proposes expansions to and operation of these development areas over a period of 25 to 30 years, including construction, operation, and decommissioning. The Project will be developed in three phases (Connacher 2009). To complete Phase I development and supply extra plant capacity, Connacher plans to drill a additional well pairs from nine well pads. Borrow pits, access roads, a surface pipeline, and laydown area will also be developed during Phase I. Additional well pads, access roads and borrow pits will be developed during Phases 2 and 3 to ensure a continued supply of bitumen for the Project expansion.

Construction, operations, and closure (decommissioning) phases of the proposed project will affect the existing vegetation, topography, watersheds, air quality, and ecosystem functioning, which may result in changes to vegetation and wetland resources.

The following assessment components are addressed in this report:

- ecosite mapping;
- non-native and invasive species,
- forestry resources;
- old growth forests;
- traditional ecological knowledge and land use;
- wetland classification and mapping;
- rare plants and rare plant communities; and
- biodiversity and fragmentation.

This report presents the vegetation and wetland resource assessment results from Fall 2006, Spring and Fall 2007, Fall 2008, and Fall 2009 field surveys. Wetland and ecosystem classification maps of the Local Study Area (LSA) and Regional Study Area (RSA) have been prepared based on the field surveys and the interpretation of aerial photographs.

1.2.2 Project Footprint (PF)

The Project is located approximately 70 kilometres southeast of Fort McMurray. The Project includes the footprint of all lands subject to direct disturbance, including proposed expansions to the Algar and Pod One footprints in three phases of development (Figure 1-1). Pod One and Algar are existing developments and are not part of the proposed project development footprint. Development of all three phases of the expansion will result in the disturbance of approximately 521 ha. The Project Footprint (PF) is situated in Township81-82, Ranges 11-12, west of the 4th meridian.

1.2.3 Local Study Area (LSA)

The Local Study Area (LSA) follows 11 Oil Sands Lease (OSL) boundaries (Figure 1-1) and encompasses the PF. The physical extent of the LSA is sufficient in size to capture potential project effects to valued environmental components (VECs) that will result from direct disturbance and also, changes to vegetation outside the PF as a result of alterations to physical components such as water quantity (wetlands). The LSA is 15,371 ha in area, and spans the following townships:

- Twp 83 Rg 12, W4M
- Twp 82, Rg 12, W4M
- Twp 82, Rg 11, W4M
- Twp 81, Rg 11, W4M.

1.2.4 Regional Study Area (RSA)

A 5 km buffer around the LSA was selected for the vegetation Regional Study Area (RSA) (Figure 1-1). The RSA was defined to ensure that it captured the furthest extent that project-specific effects are anticipated to act in combination with effects from other past, existing and anticipated future projects and activities. The RSA spans 13 townships, and is 57,459 ha in area.

1.2.5 Climate

The LSA is located within the Wabasca lowlands of the Boreal forest region of Alberta and is characterized by cool summers and long, cold winters (Natural Regions Committee 2006). The mean annual precipitation ranges from 350-500 mm. The average summer temperature for the Boreal forest region is 13.5^{o}C, and the average winter temperature is -13.5^{o}C (Strong and Leggat 1992). Records indicate that the frost-free period for this area is approximately 90 days and the annual total precipitation is 400-460 mm (Alberta Agriculture and Rural Development 2008).

1.2.6 Physiography

The RSA is located in the Central Mixedwood Natural Subregion of the Boreal Forest Natural Region within the Northern Alberta Uplands Physiographic Region. Beckingham and

Archibald (1996) classify this area within the Boreal Mixedwood Ecological Area (BM). The BM is characterized by a variety of mixed stand types including aspen, balsam poplar, paper birch, white spruce, jack pine and balsam fir stands. Medium to tall, closed stands of trembling aspen and balsam poplar with white and black spruce, and balsam fir, occurring in late successional stages, are most abundant. Understory vegetation is primarily shrubs and forbs such as prickly rose, low-bush cranberry, bunchberry, wild sarsaparilla and dewberry. Cold and poorly-drained fens and bogs are covered with tamarack and black spruce. Formed on Mesozoic and Palaeozoic sediments, the surface of this region is predominantly a gently undulating lowland plain covered with thick, loamy glacial till, clayey lacustrine, sandy fluvioglacial, and organic deposits. Organic materials cover about 50% of the area. The dominant soil types in the region are Organic, Gray Luvisols, Brunisols, and Gleysols, with some Cryosols (Beckingham and Archibald 1996). The whole region slopes gently and drains northward toward the Athabasca and Wabasca rivers. The vegetation of the region supports a variety of characteristic wildlife including moose, black bear, caribou, wolf, lynx, snowshoe hare, waterfowl, ruffed grouse, and other birds.

There is an extensive history of fire in the RSA (1980, 1981, 1982, and 1995); wildfires burned a large proportion of the area, and thus much of the vegetation is in early successional stages (Figure 1-2).

1.3 Objectives

The *Environmental Protection and Enhancement Act* (EPEA) requires a prediction of the environmental consequences of a proposed activity and the creation and assessment of plans to mitigate any adverse effects of that activity. Environmental consequences and mitigation plans cannot be determined until the existing baseline case and areas of concern are identified.

The purpose of the baseline information (Section 5) is to identify existing vegetation, wetland, and forest resources, including potential species and communities of value or concern, and to classify them according to current ecological land classification systems. Once baseline conditions have been determined, an evaluation of the potential impacts on VECs can be conducted (Section 6).

The objectives for this report come from the FTOR (AENV 2009) and are as follows:

- Describe and map the vegetation communities for each ecosite phase (after Beckingham and Archibald 1996);
- Describe and map wetlands, and discuss their distribution and relative abundance (using Alberta Wetland Inventory Standards, Halsey and Vitt 1997);
- Identify, verify and map the relative abundance of species of rare plants and the ecosite phases where they are found.
- Identify key indicators (VECs) and discuss the rationale for their selection. Identify composition, distribution, relative abundance, and habitat

requirements. Address those species listed as "at Risk, May be at Risk and Sensitive" in *The Status of Alberta Species* (Alberta Sustainable Resource Development 2005) and all species listed in Schedule 1 of the federal *Species at Risk Act*.

- Discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution. Consider their importance for local and regional habitat, sustained forest growth, rare plant habitat and the hydrologic regime.
- Describe the regional relevance of landscape units that are identified as rare.
- Provide Timber Productivity Ratings for both the Project Area and the LSA, including identification of productive forested, non-productive forested and non-forested lands.

The assessment includes a discussion of the extent, duration, magnitude, and reversibility of anticipated Project effects on VECs. Mitigation and monitoring measures are recommended to minimize and or prevent potential negative effects, and a discussion of the net effects once mitigation measures are implemented is presented.

2 INDICATORS AND ASSESSMENT CRITERIA

2.1 Valued Environmental Components

The assessment of Project effects on vegetation and wetland resources was based on six Valued Environmental Components (VECs). A scoping exercise was undertaken to determine indicators that represent vegetation resources as a whole. VECs were selected based on consultation, investigation of past reports, and expert opinion, to address the potential impacts on vegetation and wetland resources resulting from the Project. VECs and the rationale for their selection are presented in Table 2-1.

Table 2-1: Valued Ecosystem Components (VECs) and Rationale for Selection

VEC	Rationale for Inclusion
Terrestrial Vegetation	• Basis for describing baseline vegetation conditions and impacts. • Important for determining conservation and reclamation goals following Project closure.
Wetlands	• Hydrological functions and ecosystem services. • Peatlands are slow to recover following disturbance. • Important and specialized wildlife habitat.
Old Growth Forests	• Provide important wildlife habitat, structural and species diversity. • Have spiritual and aesthetic values
Non-native and invasive species	• Can alter community structure and plant species diversity • Can affect reclamation success
Traditionally Used Plants	• Important food, medicine and material sources for aboriginal communities • Necessary for traditional, cultural and spiritual customs • Berries collected near/on project area
Biodiversity	• Maintenance of biodiversity plays a key role in ecosystem functioning • Reduction of biodiversity can affect ecosystem integrity and reclamation success.

In order to assess key indicators for potential effects from the Project, baseline composition, distribution, relative abundance, and habitat requirements have been described for each VEC in Section 5 and Project effects have been described in Section 6.

2.2 Assessment Criteria

2.2.1 Spatial Boundaries

The spatial boundaries used in the assessment are those defined for the Project study areas. The PF, LSA, and RSA (Section 1.2, Figure 1-1) have been selected to define the areas existing inside and outside the boundaries of the PF development where there is a reasonable potential for immediate and cumulative environmental effects to occur as a result of Project activities.

2.2.2 Temporal Boundaries

Temporal boundaries are defined as those that will exist during the life of the Project including the construction, operation, reclamation, and closure phases. It is anticipated that the lifespan of the Project (including reclamation) will be 25 to 30 years (Connacher 2009).

Where required, temporal boundaries for cumulative effects were extended beyond closure up to 80 years after Project initiation.

2.2.2.1 Construction and Operations

The construction phase of the project is scheduled to commence in 2012. The Project is proposed to be developed in three stages, and therefore, throughout the operational life of the Project, there will be sequencing of both production and the drilling of new well pairs and construction of new well pads as older wells are depleted and subsequent stages come online (Connacher 2009). Sequential reclamation will occur throughout the operational life of the Project (approximately 25 years) of depleted well pads, borrow pits and associated infrastructure.

2.2.2.2 Closure

Final reclamation and decommissioning will occur after bitumen production operations are completed. It is anticipated that decommissioning will occur 25 to 30 years after Project initiation. The effects of the Project have been evaluated up to Project closure at 30 years (including reclamation) and where required at 50 years after Project closure, to assess residual Project effects. Fifty years after project closure was selected because it approximates the natural disturbance interval (fire rotation) of wildfire that is the dominant natural disturbance. Sequential reclamation will occur throughout the operating life of the Project and is estimated to be completely finished within a few years after operations have ceased.

2.2.3 Assessment Cases

The assessment is based on three scenarios or cases: Baseline Case, Application Case and Planned Development Case (cumulative effects). The assessment methodology is described in detail in Connacher 2010, Part C.

2.2.3.1 Baseline Case

The baseline case includes existing environmental conditions, and existing and approved projects or activities.

2.2.3.2 Application Case

The application case includes the baseline case plus the addition of the Project. A maximum disturbance scenario is used for the application case. Maximum surface disturbance occurs approximately 20 years after project initiation. The maximum disturbance scenario assumes no sequential reclamation within the PF, and all three Project phases are active until closure. Environmental effects are also assessed after closure to determine potential residual effects on vegetation and wetland resources.

2.2.3.3 Planned Development Case

The Planned Development Case includes past, existing and anticipated future environmental changes to vegetation and wetland resources that are caused by the Project in combination with existing and approved projects or activities plus planned projects or activities that are reasonably expected to occur (AENV 2009). These effects are evaluated by comparing baseline, application and existing projects, plus other planned projects that may occur within the same geographic area (spatial boundaries) and within the same and future time periods (temporal boundaries).

3 OVERVIEW

3.1 Vegetation Resources

3.1.1 Introduction

Plants are a key component in the diversity and functioning of natural ecosystems. Plants are a valuable environmental resource because they help maintain air quality, store atmospheric carbon, provide food and habitat for wildlife, provide soil stabilization, and filter and regulate water supplies. Plants also provide other valuable resources such as timber, fuel, recreation, and traditional land uses such as berry picking and plant harvesting (AENV 2003).

The distribution and occurrence of plant species differs primarily with climate, landform, topography and soil type; and secondarily with disturbance type, severity and frequency. The characteristic assemblages of species that occur on the landscape can be classified into vegetation types. As types are recognized, they can be mapped and their development can be described. This report classifies vegetation using the following classification systems:

- Alberta Vegetation Inventory (AVI) Standards; and
- Field Guide to Ecosites of Northern Alberta (Beckingham and Archibald 1996).

3.1.2 Study Objectives

The specific objectives to determine baseline vegetation characteristics and project related impacts are listed below:

- Inventory and describe existing terrestrial and aquatic vegetation, including both species and communities;
- Map plant communities by ecosite to determine ecological classification units for the study area;
- Calculate the area and percentage of the PF, LSA and RSA that each ecosite phase occupies;
- Calculate biodiversity indicators for the vegetation, including: species richness, diversity and evenness within the designated ecosites, and degree of habitat fragmentation;
- Identify any non-native invasive species and their potential effects on native vegetation;

- Identify the types of old growth forests in the LSA and determine the amount of area occupied by old growth forests;
- Assess potential effects of the Project on vegetation within the study areas, including the abundance, health, and diversity of species and communities, using both the inventory of species and biodiversity indicators information;
- Identify Timber Productivity Ratings for the LSA and RSA, and summarize the area of productive forested, non-productive forested, and non-forested land;
- Assess the sensitivity of each ecosite phase to disturbance from PAI;
- Describe techniques used to estimate sensitivity to PAI in combination with disturbance and reclamation.

3.1.3 Previous Studies

In 2005, Connacher prepared a vegetation baseline report to support the application to the Alberta Energy and Utilities Board (EUB, now ERCB) and Alberta Environment (AENV) for Pod One. Six different ecosite phases were identified, one of which was classified to plant community type (Connacher 2005). The most common ecosite phase was c1 (Labrador tea jack pine-black spruce mesic), covering 45.5% of the 57 ha surveyed. A new category, disturbed, was determined by the surveyors, which included cutblocks, well sites, roads and any other disturbed area that had a species composition that did not fall directly into one of the ecosite phases described in Beckingham and Archibald (1996). Project effects were found to be minimal due to the small size of the Project footprint, and the extensive disturbance in the area from industrial activity.

In 2007, a vegetation baseline report was prepared by GDC for Connacher to support an application to the EUB and Alberta Environment (AENV) for Algar (OSL #59) (GDC 2007a). After completion of the baseline report, the location of the Algar development footprint was updated, and an amendment to the baseline report and a pre-disturbance report were prepared to document changes to the original findings (GDC 2007b, 2008). Nine different ecosite phases were identified in the Algar development area. Of the nine, ecosites c1 and i1 (treed bog) were the most common, representing 33.7% and 24.7% of the footprint, respectively. Since none of the observed ecosites were uncommon to the area, and the Project disturbance area was relatively small (120.4 ha), no mitigation was recommended with respect to vegetation resources other than implementation of reclamation plan.

A separate assessment for the effects of 3D seismic lines was performed in the 2007 vegetation and wetland resource survey. The effect of 3D seismic on vegetation was found to be short-term and low in magnitude. Site conditions, seed, and propagule establishment were found not to be significantly altered because of winter with frozen soil conditions, the maintenance of mature trees, that no biomass was to be removed from the site, mulch was to be small diameter woody species that was dispersed evenly, most of the affected shrubs reproduce well by sprouting and suckering once established, and the small width and undulating pattern of trails was not expected to significantly affect microclimate (Connacher 2007). The 3D seismic was assessed to have a short-term (2-5 years) effect on vegetation in the area. As well, because of the early successional stage of much of the area due to the 1995 wildfire, seismic lines were not considered to be a successional setback for most of the area.

3.1.4 Vegetation Elements

3.1.4.1 Vegetation

In order to retain the values of the vegetative resources within the study area, an assessment of which species, communities, and ecosites are currently present, and their abundance, is important. This assessment can then be used to determine how much of the vegetation will be directly affected and in what way, allowing potential mitigation strategies to be developed.

3.1.4.2 Ecological Classification

The ecological classification system used for this project is that of Beckingham and Archibald (1996). It incorporates vegetation, soil, site, and productivity information to classify ecosystems to ecosite phase. Under this system ecosites are defined relative to the modal or reference site within a particular natural subregion. In this construct, the modal or reference site refers to a site that is more strongly influenced by the regional climate than by edaphic (soil) or landscape features, and as a result is typified by moderate soil moisture and nutrient conditions. This system of ecosite classification is hierarchical and follows the order (from largest to smallest):

- Natural region and Subregion/Ecological area (mapped at 1:1,000,000 scale);
- Ecosite (mapped at 1:20,000 scale);
- Ecosite phase (mapped at 1:15,000 scale); and
- Plant community type (mapped at 1:5000 scale).

The Natural Regions and Subregions of Alberta form the base of the system and represent distinct landscapes that are delimited and classified on the basis of unique climatic, geomorphological, physiographical, and ecological characteristics. Ecosystem classification within this framework is used to further distinguish and classify ecosystems and associated plant communities as follows:

- Ecosite, which forms the functional unit, is defined on the edatopic grid by nutrient and moisture regimes in an area with similar climatic and environmental conditions (Figure 3-1). Ecosite is identified by a letter increasing from “a” to the last letter used; in the case of the Boreal Mixedwood ecological area, letters go from “a” to “l”.
- Ecosite phase, which is based on the dominant tree species, or tallest physiognomic vegetation layer if trees are not present (e.g., shrubs), represents the smallest mappable unit. Ecosite phase correlates well with traditional forest cover maps and is identified with a letter number

combination, with the letter representing the ecosite and the number representing the phase within that ecosite (e.g., c1, d1, d2).

- Plant community type, which is characterized by the dominant understory plant species, but also includes the overall plant community. Plant community type is identified by a number that follows the ecosite phase (e.g., c1.1, d1.2, d2.1) (Figure 3-2).

3.1.4.3 Forestry Resource

Forests comprise much of the Boreal Forest Natural Region, where the proposed Project is located. Forests are a valuable resource because they help maintain air quality, store atmospheric carbon, provide habitat for wildlife, keep soil in place, filter and regulate water supplies, support recreational activities, and harbor valuable resources such as timber, fuel, and traditional land uses such as berry picking and plant harvesting (Alberta Environment 2003, Alberta Environmental Protection 1998). Alberta's forested lands maintain about 460 species of vertebrates, about 1300 species of vascular plants, about 600 species of non-vascular plants, and about 10,000 species of invertebrates (Alberta Research Council 1998). Forests also provide aesthetic, spiritual, and cultural values to society (Alberta Environment 2003a).

Timber productivity ratings (TPR) are given in the AVI data and can be used to determine productive and non-productive forested lands and merchantable volumes.

3.1.4.4 Old Growth Forests

Old growth forests differ from younger stands in both structure and function. The canopy is composed primarily of old trees, although there is considerable heterogeneity within the stand. Other unique characteristics of old growth stands include an accumulation of snags and downed woody material, which provide habitat for a broad range of wildlife, and increased species and genetic diversity.

The definition of what constitutes an old growth forest varies depending on the reference used, and can be defined by criteria involving age and or stand structural characteristics. The age-based definition proposed by Schneider (2002) was chosen, because age-based definitions can be easily applied using Alberta Vegetation Inventory (AVI) data. Old growth is defined according to tree species, using the following criteria:

- White spruce, black spruce, and tamarack forests: 140 years or older
- Pine forests and mixed pine-spruce/tamarack forests: 120 years or older
- Deciduous and mixed coniferous-deciduous forests: 100 years or older

"Mixed" stands are defined as those with less than 80% cover of the dominant tree species, and more than 20% of the tree type that would otherwise give younger old growth criteria. For example, a stand with 60% black spruce, 20% tamarack, and 20% birch would be considered old growth at 140 years or older, but one with 50% black spruce, 20% tamarack, and 30% birch would be considered old growth at 100 years or older. Stand origin data from the AVI data for the LSA were used to determine the stand ages, and were rounded to the nearest decade.

3.1.4.5 Traditional Ecological Knowledge and Land Use

Managing traditionally valuable vegetation is not as simple as identifying populations and protecting them. The efficacy of the plants for spiritual and medicinal uses depends not only on the species, but also on the habitat in which they were collected. The perceived health of the plant, season, time of day, cultural rites to gathering area (passed on through families) are important considerations which help determine whether plants will be collected or not. The importance of specific plant species also depends on whether local Aboriginal communities actually use those plants (plants identified to be used in one region by specific communities, might not be used at all by communities in another region). Further, the spiritual worldview of Aboriginals on which the medicines and ceremonies rely require a good rapport between healer, patient and the spirit world (Marles *et al*. 2000; AYXS Environmental Consulting Ltd. 2000).

Traditional Land Use Studies (TLUS) involve consultation with local Aboriginal peoples to determine local areas or species that are important for food, medicine, and for spiritual reasons. Local traditional ecological knowledge, opinions and concerns are then incorporated into baseline assessments and mitigation recommendations to protect these valuable traditional resources.

A plant species and plant community approach has been used in the assessment that incorporates the findings from the consultation process with local communities (Connacher 2010, Part F).

3.1.4.6 Potential Acid Input and Nitrogen Deposition

Acid deposition can generally be considered in terms of indirect effects of acid deposition, and direct effects from acidifying components including nitrogen and sulfur compounds. Acid effects on vegetation are not often considered directly because effects on soil and water occur earlier and are more easily measured (Clean Air Strategic Alliance 1999) and acid input usually affects vegetation indirectly through changes in soil or water chemistry. Plant communities on soils that are sensitive to potential acid input (PAI) may be affected depending on the rates of deposition and changes in soil chemistry. Therefore, this section focuses on direct effects from nitrogen, and indirect effects from acid deposition are considered in terms of effects on soil chemistry (MEMS 2010a).

Nitrogen deposition is known to affect the growth rate, and hence species composition, of plant communities (Kellner and Redbo-Torstensson 1991, Köchy and Wilson 2004). The effects of nitrogen deposition depend on the species within communities (Heijmans, 2001); however, nitrogen-limited ecosystems are considered to be among the most sensitive. The majority of ecosystems in Alberta's Boreal Forest Natural Region are nitrogen limited (Bobbink and Roelofs 1995; Fenn *et al*. 2003), but bogs are particularly sensitive. Acceptable limits of nitrogen deposition are measured in critical loads (kg ha^{-1} yr^{-1}). Estimations for acceptable critical loads in forested ecosystems range from 0.5 kg ha^{-1} yr^{-1} (Baron 2006) for lake, to 18 kg ha^{-1} yr^{-1} in raised bogs (Lamers *et al*. 2000).

Several species of mosses, including *Sphagnum* sp., and several species of lichens are more sensitive to nitrogen deposition because they take nutrients directly from the air and water (Wieder *et al.* 2010, Fenn *et al*. 2007). In turn, ecosystems with high lichen or moss composition are considered particularly sensitive to nitrogen deposition.

3.2 Wetlands

3.2.1 Introduction

Wetlands are defined by the National Wetlands Working Group (NWWG 1988) as "land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation and various kinds of biological activity which are adapted to a wet environment." Wetlands are categorized into two groups: peatlands and non-peat forming wetlands (Halsey and Vitt 1997). Peatlands, usually having greater than 40 cm of accumulated organic matter, are subdivided into bogs, fens and some swamps. Non-peat forming wetlands, usually having less than 40 cm of accumulated organic matter, are sub-divided into three groups: shallow open water, marsh, and other swamps. Each of these wetlands is formed by a combination of geomorphic, hydrologic, edaphic, climatic or biological factors.

Wetlands and riparian areas are unique ecosystems in regards to the many values and functions they serve (e.g., important and specialized habitat, water quality, carbon sequestration), and as such they are governed by specific regulations, particularly with respect to conservation and reclamation.

3.2.2 Study Objectives

The purpose of the wetland assessment was to acquire baseline data on all wetlands, peatlands, and riparian plant communities, as well as to map and describe wetlands following the Alberta Wetland Inventory Standards (Halsey and Vitt 1997). The specific objectives required to accomplish this were as follows:

- Characterize all riparian/wetland vegetation communities according to the appropriate classification guides (Alberta Wetlands Inventory Standards);
- Describe wetland vegetation community distribution, structure, and diversity; and
- Establish a detailed mitigation and reclamation strategy to minimize project and cumulative effects (especially in regards to land use and fragmentation) and identify any proposed setbacks around riparian areas and wetlands.

3.2.3 Previous Studies

In 2005, Connacher identified three wetland types within the Pod One development area, and these were wooded swamp (STNN), wooded fen (FTNN) and shrubby swamp (SONS) (Connacher 2005). Wooded swamps (STNN) were the dominant wetland type (34%) and included all g1 and h1 ecosite phases, FTNN defined all j2 ecosite phases, and SONS defined k2 ecosite phases.

In 2007 and 2008, Connacher found four types of wetlands in the Algar development area, covering 53.6% of the final project footprint (Connacher 2007, GDC 2008). Treed bogs (BTNN) were the most common, occupying 35.6% of the footprint. Open graminoid fens (FONG), open shrubby fens (FONS), and treed fens (FTNN) were also present, occupying 18% of the Algar footprint. No wetlands of limited distribution were identified. The wetlands within the Algar footprint were also common in the rest of the lease area. It was concluded that the Algar project would have minimal effect on wetlands in the study area as they are locally and regionally common, and mitigation other than implementation of the reclamation plan was not recommended.

3.3 Rare Plants

3.3.1 Introduction

A rare plant is defined by the Alberta Native Plant Council (ANPC) as “any native vascular or non-vascular (mosses, hornworts, liverworts) plant that, because of its biological characteristics or for some other reason, exists in low numbers or in very restricted areas in Alberta” (ANPC 2000a). This definition also applies to lichens and fungi. Although too little information exists on fungal distributions for them to be included in rare plant surveys, lichens are included.

The occurrence of rare plants is influenced by a range of factors that affect their geographic range, habitat specificity, and population size (Rabinowitz 1981). Alteration of the natural environment results in changes in biotic and abiotic factors that influence the presence of rare plants. Influential biotic factors include the introduction of a non-native, invasive plant that may displace the rare plant (competition), or the presence of a new insect or herbivore. An example of an abiotic factor that may contribute to plant rarity may be a change in the microclimate or alteration of drainage patterns of its habitat. With this in mind, indirect changes within the ecosystem may also affect rare plant species. More than 110 rare species (approximately 25% of Alberta’s rare vascular plants) occur in the Boreal Forest Natural Region (Kershaw *et al*. 2001).

A rare plant community is any community that is uncommon, of limited extent, or locally significant, and only natural communities are considered (ANHIC 2010). ANHIC ranks, maps, and tracks rare species and rare communities (each one called a tracking element) in Alberta. They use a ranking method that is based on a system developed by The Nature Conservancy. The ranking method that is used throughout North America and catalogues rare plant species is as follows (S = Provincial, G = global) (Gould 2006):

- S1/G1 – Five or fewer recorded occurrences, or with few individuals remaining
- S2/G2 – Six to 20 occurrences or many individuals in fewer occurrences
- S3/G3 – From 21 to 100 occurrences; might be rare and local throughout its range, or its range might be restricted (may be abundant at some locations or may be vulnerable to extirpation because of some biological factor)

- S4/G4 – Secure under present conditions, typically with more than 100 occurrences; or, fewer with many large populations (may be rare in parts of its range, especially at the periphery)
- S5/G5 – Secure under present conditions with more than 100 occurrences; may be rare in part of its range, especially the periphery
- SNR – Status not yet ranked
- SU/GU – Status uncertain, often because of low search effort or cryptic nature of the element; possibly in peril, not rankable, more information needed
- S?/G? – Rank questionable

The ranking of a plant species or community as rare within this study follows ANHIC's definition; that is, all S1, S2, and some S3 species are on the tracking and watch lists, and are considered rare. A combined rank (e.g.: S1/S2) is given for species whose status is uncertain; with the first rank indicating the rarity status given current documentation, and the second rank indicating the rarity status that will most likely be assigned after all historical data and likely habitats have been checked.

Elements with S1 to S2/S3 ranks are recorded on ANHIC's tracking lists because they are species of high priority or conservation concern. Depending on population characteristics, some species with ranks of S3 or S3/S4 are placed on watch lists, along with historically present species (SH) and some status undetermined species (SNR). Species on watch lists are usually those that have restricted distributions but are common within their range. Elements on the tracking and watch lists are evaluated annually, and they may move from one list to the other depending on whether their populations increase or decrease (Gould 2006). Species are also ranked globally according to their global distribution (NatureServe 2009).

3.3.2 Study Objectives

The purpose of the rare plant survey was to identify and map rare plants and communities occurring within the PF and LSA. Specific objectives were:

- Inventory, map and describe rare species and communities;
- Conduct a rare plant survey following recognized survey protocols including a literature search, a search of Alberta Natural Heritage Information Centre (ANHIC) records, and a field survey;
- Discuss the project effects on rare plant species and communities; and
- Discuss the potential of each ecosite phase to support rare plant species.

3.3.3 Previous Studies

In 2005, Connacher conducted a rare plant survey which identified 15 rare bryophyte species within the Pod One footprint. No rare vascular or lichen species were found. It was recommended that Connacher shift the project footprint where possible to avoid the rare bryophytes, and where this was not possible, mitigation to include colony transplants for five of the fifteen species was recommended.

In 2007 and 2008, one rare liverwort, *Cephaloziella rubella,* and three rare lichens, *Bryoria simplicior, Cladonia bacilliformis,* and *Cladina stygia*, were found within the Algar study area (GDC 2007a, 2007b, 2008). Since all four rare plants were observed multiple times outside the project disturbance footprint, and because all were globally ranked apparently secure, likely secure, and secure, mitigation was not recommended (GDC 2008).

3.4 Biodiversity

3.4.1 Introduction

Vegetation is a key component of biodiversity. Biodiversity, as defined by the Canadian Biodiversity Strategy (Minister of Supply and Services 1995), is "*the variability among living organisms and the ecological complexes of which they are part…[including] within species, between species, and diversity of ecosystems*". The Strategy further states that "*conservation of biodiversity means managing human uses of resources to maintain ecosystem, species and genetic diversity*" (Minister of Supply and Services 1995). Alberta has adopted this mandate, and put in place many initiatives to show the importance of vegetation to biodiversity. For example, the setting aside of protected areas and Special Places, the creation of the Alberta Forest Conservation Strategy, and the establishment of model forests for research, all demonstrate the important role vegetation plays in the conservation of Alberta's biodiversity (Alberta Environmental Protection 1998).

In order to achieve the goals set out in Sustaining Alberta's Biodiversity: An Overview of Government of Alberta Initiatives Supporting the Canadian Biodiversity Strategy (AEP 1998), biodiversity measures were included at the landscape, community (ecosite phase), and species levels.

Because biodiversity is such a broad concept, several measures can be used to describe it. The method employed for any one dataset is dependent on the use of the data in question. For the purpose of this report, biodiversity is measured in terms of vegetation type (synonymous with patch type or patch class in most fragmentation analysis literature) richness, evenness and diversity. Richness is the simplest measure of biodiversity and is accomplished by counting the number of patches present (landscape level), or species within patches (community and or species level). Evenness refers to the equitability of allotment of patches between the vegetation types. Diversity can also be measured using an index (e.g., Shannon Weiner), which incorporates the richness and the evenness of the allotment of patches. Tables that rank patches by how many species, or types of species, they can support is another common measure of biodiversity.

A key element to biodiversity is the effects of fragmentation. Ecosystem fragmentation refers to the break-up of habitat expanses into smaller and more isolated units. Increased ecosystem fragmentation may result in a wide range of threats to biodiversity, such as an increase in invasive and non-native species, reduction or restriction of wildlife movement, reduction of genetic diversity and population viability. Fragmentation and biodiversity are co-dependent in that as fragmentation of natural landscapes increases, so does the loss of biodiversity.

3.4.2 Study Objectives

The objectives of the biodiversity study were to assess abundance and distribution of species at several scales across the landscape, as well as to assess fragmentation of the landscape within the study area. Specific objectives were:

- Assess the biodiversity potential of each ecosite phase;
- Assess fragmentation of ecosites in the landscape; and
- Discuss the Project effects on biodiversity and fragmentation.

3.4.3 Previous Studies

In 2007, a vegetation baseline report was prepared by GDC for Connacher to support an application to the EUB and AENV for Algar (OSL #59) (GDC 2007a). Baseline biodiversity was assessed with respect to plant species richness by ecosite and ecosite phase. 113 different species were found in 17 rare plant sample plots. The plant community types with the highest mean species richness values in the Algar footprint were found in k2, j1, and j2 ecosite phases. The lowest mean species richness values were found in the b1, k2 and k3 ecosite phases.

4 METHODS

4.1 Vegetation

4.1.1 Pre-Survey Methods

Before field surveys, preliminary maps were created depicting ecosite phase, based on interpretation of orthophotographs and aerial photographs of the area, as well as Alberta Vegetation Inventory (AVI) maps and database. Aerial photos for the LSA and RSA were taken in 1988, 1998 and 1999 at 1:15,000 scale. The canopy closure, stand height, most prevalent tree species, moisture regime, and non-forested land descriptions (industrial) were used from the AVI database. The available AVI was based on air photos taken after the 1995 wildfire when the majority of the vegetation in the study area was in early successional stages. This resulted in AVI data being inconsistent with expected ecosite phase. Within the burned areas, it was necessary to examine all polygons individually using stereoscopes. From differences in grey tones and elevation interpreters could delineate ecological units across the study. The extent of the fire history in the RSA is presented in Figure 1-2.

The AVI database polygons were edited to define ecosite phase boundaries. AVI data do not effectively delineate bogs and fens or consider changes in elevation. Line changes within the AVI polygons were done using the orthophotos and the 1:15,000 scale aerial photos. When classifying polygons containing multiple ecosite phases, only the two most dominant ecosite phases were included. Polygons were not classified to the plant community type level because understory plant species can not be identified through the use of aerial photos alone. Ecosites and ecosite phases are described in Appendix 3.

The interpreted preliminary ecosite phase maps were then used to locate and stratify potential sample sites for detailed ecosite phase classification in the field. Sampling plot locations were selected to encounter the broadest range of ecosite phases within the PF and LSA. Wherever possible, a minimum of five sample plots per ecosite phase was targeted.

4.1.2 Field Survey Methods

4.1.2.1 Mapping

Following satellite-image and aerial photo interpretation and initial map delineation, field verification of many polygons was conducted in conjunction with field surveys. Notes, with regards to polygon changes, were made in the field, and then incorporated into the GIS coverage of the PF and LSA. Additional notes and corrections were made during each successive field trip to improve the accuracy and detail of mapping. Field surveys were not conducted in the portion of the RSA that extends beyond the LSA, thus mapping of this area of the RSA was based on air photo interpretation and AVI data only.

4.1.2.2 Plot Based Data Collection

The data collection protocols used for the vegetation surveys followed the guidelines outlined in the Ecological Land Survey Site Description Manual (AEP 1994). All field plots (detailed ecosite and rare plant) were marked at the center with flagging tape denoting the plot number, date, and surveyor initials. Plot location was recorded at plot center with a GPS unit and one or more photographs of a representative area of the site were taken. Additional photographs were generally not taken on repeat visits to rare plant plots.

Detailed ecosite plots involved a complete survey of site and vegetation characteristics, including a small 60 cm deep soil pit, used to describe the general soil and site conditions. An AVI code (density, height, and dominant tree species) was applied to the site using a 20 x 40-m plot size. A detailed vegetation inventory was conducted within a 10 x 10 m plot representative of the site. All plants, including mosses and lichens, were identified to species level and their associated percent cover recorded to the nearest percent, with the exception of epiphytic species, which were recorded as part of the rare plant survey but not as part of the detailed vegetation inventory. All species were assigned a strata from 1-9 based on which vertical vegetative layer they were in (Table 4-1).

At all ecosite plots a rare plant survey was also performed. This included surveying not only plants within the detailed ecosite plot area (100 m^2), but also performing wander searches within the polygon until no new plant species were found. Rare plant plots involved the collection of detailed vegetation and basic site information: see Section 4.3 for a complete description of rare plant survey methods. Table 4-2 summarizes the data that were collected as part of the vegetation resources survey. If a plot was in a wetland, it was further classified to its type and class of wetland. A description of the wetland classification methods is described in Section 4.2.

If a plant could not be identified in the field it was collected and preserved for later identification by a plant taxonomist. The Alberta Native Plant Council (ANPC) Plant Collection Guidelines were followed (ANPC 2006). In the case where there were insufficient plants to allow for collection, photographs, detailed descriptions, and the collection of key plant parts allowed for subsequent identifications. Specimens for identification were preserved by pressing vascular plants, and by oven-drying mosses and lichens in paper packets.

Table 4-1: Description of strata and associated vegetative layers

Strata Number	Strata Description
1	Overstory tree canopy
2	Understory tree canopy
3	Tall shrub (2.5-5 m)
4	Short shrub (less than 2.5 m)
5	Forb
6	Grass
7	Moss/liverwort
8	Lichen
9	Epiphytic lichen or moss

Table 4-2: Data collected in the Project Area

Site Data	-	plot number
	-	date
	-	plot type
	-	surveyor
	-	photo numbers
	-	GPS coordinates
	-	Field AVI type
	-	natural subregion
	-	ecosite, ecosite phase and community type
	-	ecosite fit
	-	surface shape and expression
	-	moisture regime
	-	nutrient regime
	-	aspect
	-	slope, slope position, and slope length
	-	site comments
	-	landscape profile diagram
Vegetation Data	-	strata
	-	plant species name
	-	percent cover*
Soils Data	-	organic surface thickness
	-	humus form*
	-	parent material*
	-	surface expression*
	-	texture and coarse fragment abundance and size for 0-20 cm, and 20-60 cm*
	-	thickness of Ah, Ae, and total organic layers*
	-	depth to root restriction, mottles, gleying, water table, bedrock/frozen, and bottom of pit*
	-	soil drainage*
	-	soil type*
	-	presence and contrast of mottles*
	-	soils comments*

*Collected for detailed ecosite plots only

Vegetation surveys were conducted five different times between 2006 and 2009. The surveys were concentrated on areas of the LSA where development was expected. To improve mapping accuracy and detail, as well as sampling efficiency, ecosite information was collected during both the rare plant and detailed ecosite plot surveys. A fall rare plant survey was completed late August – early September, 2006, with 79 rare plant plots established. A “spring” survey was completed in late June-early July 2007, when 62 of the initial 79 plots were revisited, and detailed ecosite plots were established at 29 rare plot locations. Also in the spring, another 54 ecosite plots and 31 rare plots were established across the LSA. These were then resurveyed in late July 2007. In 2008, an additional 16 rare plant survey plots established and in 2009, 36 more rare plant plots were established. Sample plot distribution is presented in Figure 4-1.

Since reproductive and flowering structures are often required to correctly identify many species of vascular plants, timing of the spring and fall field visits was planned to coincide with both early and late flowering species. For this reason and because of the late spring melt and short growing season in the Boreal Forest Natural Region, the "spring" field survey was conducted in late June – early July.

4.1.3 Post-Survey Methods-Mapping

Vegetation mapping was completed for the PF, LSA, and RSA following completion of the field surveys. The wetlands and riparian areas were mapped along with the upland vegetation using the Beckingham and Archibald (1996) ecosite phase classification system. All polygons that were pre-stratified to ecosite phase before the field survey, then were checked against field plot data and given a final ecosite phase classification (up to two different ecosite phases per polygon). The polygons were then turned into an ecosite phase classification map for the different study areas.

4.1.4 Quality Assurance and Quality Control

4.1.4.1 Field Surveys

Quality assurance and control methods used in the collection of field data included:

- Selecting sites across the study areas to ensure good representation of all vegetation types;
- Selecting sites in homogenous vegetation to ensure accurate vegetation type and wetland class designations;
- Reviewing sites done at the end of each shift to ensure adequate numbers of each vegetation type were sampled;
- Reviewing data sheets daily to make certain they were complete, legible, and accurate; and
- Reviewing plant specimens collected daily to ensure proper labeling and identification, if species was known.

4.1.4.2 Office

Quality assurance and control methods used in the office for data processing included:

- Incorporating other baseline field data and reports from adjacent areas within the LSA;
- Ensuring field data were entered properly into the database through quality checks and database queries;
- Sending plant specimens that were difficult to identify or thought to be rare to an external qualified plant taxonomist;
- Assuring plant species names were the most up to date and accurate; and
- Using aerial photographs to supplement field vegetation type and wetland class designations in the creation of maps.

4.1.5 Data Analysis

4.1.5.1 Vegetation

Field data from sample plots were entered into a Microsoft Access database for summary and analysis. The database was subsequently queried to pull out relevant information for further analyses. Preliminary maps were revised to show vegetation and wetland resources. Polygons classified to ecosite phase were queried, and the area that each ecosite phase occupies in the PF, LSA, and RSA were summarized.

The field survey species lists were compared to tables of non-native, invasive, and agronomic invasive species of Alberta (ANPC) and a database query identified the presence and location of non-native and invasive plant species.

4.1.5.2 Rare Plant Potential

The definition of a rare species in Alberta follows that of the Alberta Natural Heritage Information Centre (ANHIC). This system is based primarily on the number of occurrences of a given element (i.e., taxonomic rank – usually species) within the province and, to a lesser extent, by factors that influence their ability to sustain the population (e.g., life history factors, responses to disturbance.).

In order to predict where rare plant species may occur within Boreal Mixedwood ecological area, GDC has developed a predictive rare plant occurrence potential model based on plot data collected at 1,094 survey sites in the oil sands area. The model is designed to provide a direct association between each rare plant species and their associated habitat types. The association is based on the following assumptions:

- plant species requirements represent habitat types;
- habitat type connects species with ecosite phase;
- ecological area will form the framework for analysis of rare plant occurrence potential; and
- variable survey methods did not affect the type or number of species observed.

The model was developed to provide baseline ecological sensitivity ratings of rare plant potential based on ecosite phase, and thus, provides a measure of the extent of potential rare plant habitats.

The output results of the model were subsequently adjusted to an interval between 0 and 100 before being normalized with 0-mean and 1-standard deviation. Thereafter, the habitat types were grouped into five nominal classes of rare plant potential, each of which represents two successive deciles from the normalized distribution. Rare plant potential classes are very low (VL), low (L), moderate (M), high (H), and very high (VH).

4.1.5.3 Forestry Resource

Forestry resources were determined using timber productivity ratings (TPR) from the AVI data. The Project falls entirely within the Forest Management Area (FMA) of Alberta-Pacific Forest Industries Inc. (Al-Pac) who are responsible for collecting and maintaining the AVI database. Al-Pac utilized both aerial photograph interpretation and field visits to gather the AVI attribute data. Polygons given TPR of “good”, “medium”, and “fair” are combined with stand type to determine the volume and area of the total productive forested land. Stands that were given an unproductive rating (U) were considered unmerchantable. Productive volumes were calculated according to the stand type represented by the AVI polygon. Each polygon was classified into 1 of 4 cover classes based on lead species percentages (Table 4-3). Volumes of each polygon were determined using the crown class closure, stand height, cover class designation and the Timber Damage Assessment Modified AVI format stand volume table (ASRD 2009). Type of timber was determined using the dominant species in a polygon (Table 4-4).

Table 4-3: Definitions of attributes and characteristics of the Alberta Vegetation Inventory.

Characteristic	Value	Value Description
Crown class values	a	6 - 30% cover
	b	31 - 50% cover
	c	51 - 70% cover
	d	71%+ cover
Height values	1 thru 35	height of canopy in 1 m increments
Timber Productivity Rating	G	Good
	M	Medium
	F	Fair
	U	Unproductive (non-merchantable)
Species	sp1 thru sp 5	name of species in order of most dominant to least dominant
	per 1 thru per 5	percentage of species listed in intervals of 10%
Cover class (stand type)	C	Conifer (80% or more conifer content)
	C-D	Conifer dominant mixedwood (conifer content between 50% -70%)
	D-C	Deciduous dominant mixedwood (deciduous content between 50% and 70%)
	D	Deciduous (80% or more deciduous content)

Table 4-4: Legend of leading species content in Alberta Vegetation Inventory.

Code	Leading sp
SW	White spruce[1]
SB	Black Spruce[2]
PL	Lodgepole Pine[3]
AW	Trembling Aspen[4]

[1]SW includes: FA=alpine fir; FB=balsam fir; SE=englemann spruce; SW=white spruce; FD=douglas fir; LA=alpine larch; LW=western larch;
[2] SB includes: LT=tamarack; SB=black spruce;
[3]PL includes: PL=lodgepole pine; PJ=jack pine; PA=whitebark pine; PF=limber pine
[4]AW includes: AW=trembling aspen; PB=balsam poplar; BW=paper birch.

4.1.5.4 Old Growth Forests

The presence of old growth forests was determined using the stand origin data from the AVI stand data. The extensive wildfire history in the study area did not impact determination of old growth forests as the age of the AVI is more recent than that of the most recent wildfire. As described in Section 3.1.4.4, old growth for white spruce, black spruce, and tamarack forests was determined at 140 years or older, for pine and mixed pine-spruce/tamarack forests at 120 years or older, and for deciduous and mixed coniferous-deciduous forests at 100 years or older.

Age Class Distribution by Forest Types

The Beckingham and Archibald (1996) ecological classification system does not include age and therefore a separate analysis is required to examine how the project will impact the future forest age distribution, including old growth forests. In order to quantify Project effects on forest age distribution, an understanding of the natural range of variation (NRV) is required. This understanding must incorporate the types of forest (e.g., canopy species), the regional climate, and, within the Boreal Forest Natural Region, how they interact with the wildfire regime. A framework for the NRV was created by the Sustainable Ecosystems Working Group (SEWG) of the Cumulative Effects Management Association (CEMA). The CEMA report “Natural Levels of Forest Age-class Variability on the RSDS Landscape of Alberta” (Andison 2005) describes the natural range of variation in age distribution by forest type for seven landscape units in the oil sands region. The information provided in Andison (2005) represents the best available information on age distribution and is specific to the Project study area (i.e., LU4 in Andison 2005). The NRV will be used as a backdrop to address the following:

1. How does the landscape now, and in the future, break down into very broad classes of forest types and ages?
2. How do these compare to the regional landscape (with and without the project)?
3. How might this affect the potential for the development of old growth forest in the future?

The boreal forest is dependent on natural disturbance, particularly fires, to maintain ecological form, function and diversity. At the landscape level, the three most important aspects are fire frequency, size, and shape. By focusing the assessment at the landscape scale, a fire regime or behaviour that can be considered random over a small area and several years, becomes more predictable over large areas and hundreds of years (O'Neill *et al*. 1986).

Age Distribution Model Assumption and Methods

The objective of the forest age class modelling was to identify the current landscape pattern and age classes distribution for the RSA, and to assess potential effects of the Project on age class distribution at Time 80 (80 years from the Baseline Case). The assessment of significance will be on Time 80 because it represents approximately one natural fire rotation after Project closure.

Five assumptions are included in the model used to assess age class distribution:

1. Five forest types are used (Andison 2005): Pine, Black Spruce, Conifer, Hardwood, and Mixedwood (see Table 4-5 for description).

2. Forest type is stable over time. Forest type is a reflection of many factors such as soil moisture regime, soil nutrient regime, forest successional stages, seed bed conditions and disturbance regime. This assumption is not realistic for any one particular stand, but is a safe assumption from a landscape perspective since site-level shifts in species composition will be balanced out across the entire region (Andison 1996).

3. The entire PF is assigned an age of zero until reclaimed/planted in year 30; this is consistent with the maximum disturbance scenario used in the vegetation impact assessments.

4. Maximum allowable age is 250 years for the Conifer forest type, and 200 years for hardwood and mixedwood forest types. Forest stands that exceed these ages are reset to the young age class.

5. Indicators of disturbance regime and pattern from Andison (2005) have been used in this assessment.

Table 4-5: Forest types and Age Classes used in the Assessment

Forest Type	Tree Composition	Age Classes			
		Young	Immature	Mature	Old
Pine	>= 80% Pine	0-30 yrs	31-80 yrs	81-120 yrs	> 120 yrs
Black spruce	>= 80% Black spruce	0-30 yrs	31-80 yrs	81-120 yrs	> 120 yrs
Other conifer	>= 80% Conifer Mix	0-30 yrs	31-80 yrs	81-120 yrs	> 120 yrs
Hardwood	>= 80% Hardwood	0-20 yrs	21-60 yrs	61-120 yrs	> 120 yrs
Mixedwood	< 80% Hardwood	0-20 yrs	21-60 yrs	61-120 yrs	> 120 yrs
Unknown	Unknown	0-20 yrs	21-60 yrs	61-120 yrs	> 120 yrs

A 2-year time interval was used and the average historical fire disturbance rates in the region were applied. The fire rotation and annual disturbance rate used in the model are specific to each forest type. For Jack pine, the fire rotation was determined to be 49.8 years with 2.0% annual disturbance rate, black spruce was 48.4 years with 2.1 %, conifer was 45.6 years with 2.2 %, mixedwood was 52.2 years with 1.9 %, and hardwood fire rotation was 64.9 years with 1.5% annual disturbance rate. Details on these parameters are provided in Andison (2005). Figure 4-2 illustrates an example of the expected distribution for Jack pine with a fire rotation of 49.8 years.

4.1.5.5 Traditional Ecological Knowledge and Land Use

Traditional land use consultation for the Project has begun and is ongoing. In addition to Aboriginal consultation meetings, several traditional land use studies (TLUS) have taken place in the Fort McMurray region, and one in particular used a study area that overlaps the Connacher project RSA (AYXS Environmental Consulting Ltd. 2000). A number of plants identified as valuable for their traditional uses by this TLUS were also indicated to have traditional value during the consultation process for the Project.

A list of species identified as important for food, medicine and for spiritual uses by local knowledge holders was compiled. The potential ecosites these species could be found in have been identified based on botanical experience and knowledge of the authors of this report, specific habitat requirements of each species (Beckingham and Archibald 1996), and plot data collected in the Connacher LSA. The traditional plants identified to be of importance by local Aboriginals and the associated ecosites are presented in Appendix 5.

From this list, the potential for ecosites to support traditionally used plants was predicted based on the number of these plants that could be expected in each ecosite phase. Predictions of potential were given rankings of “Low,” “Moderate,” and “High” based on the number of traditionally used species that can be present in those ecosite phases. The rankings were determined as follows:

Low: 1-15 species

Moderate: 16-25 species

High: >25 species.

4.1.5.6 Potential Acid Input and Nitrogen Deposition

PAI effects vegetation through indirect effects on soils. PAI effects on vegetation and wetland resources has only been assessed for the vegetation RSA based on the results from the air quality report (MEMS 2010b).

Most ecosites in the Boreal Forest Natural Region are nitrogen limited, and therefore sensitive to nitrogen deposition. Ecosite phases present in the RSA were assigned a sensitivity rating based on their composition of lichens and mosses (Table 4-6). Critical loads were assigned following Vitt *et al.* 2003 as 15 kg ha^{-1} yr^{-1} for sensitive ecosites, and 20 kg ha^{-1} yr^{-1} for moderate and low-sensitivity ecosite phases.

Nitrogen deposition contours were then overlaid on the ecosite map to assess critical loads for the baseline case and potential changes to ecosites receiving critical nitrogen deposition loads as a result of changes in air quality from the Project.

Table 4-6: Sensitivity of ecosites to nitrogen deposition.

Ecosite Phase	Sensitivity Rating	Critical Load kg ha^{-1} yr^{-1}
b1 - blueberry Pj-Aw	High	15
b2 - blueberry Aw(Bw)	Moderate	20
b3 – blueberry Aw-Sw	Moderate	20
b4 – blueberry Sw-Pj	High	15
c1 - Labrador tea-mesic Pj-Sb	High	15
d1 - low-bush cranberry Aw	Moderate	20
d2 - low bush cranberry Aw-Sw	Moderate	20
d3 - low bush cranberry Sw	Moderate	20
e1 - dogwood Pb-Aw	High	15
e2 - dogwood Pb-Sw	High	15
e3 - dogwood Sw	High	15
f1 - horsetail Pb-Aw	High	15
f2 -horsetail Pb-Sw	High	15
f3 - horsetail Sw	High	15
g1 - Labrador tea –subhygric Sb-Pj	High	15
h1 - Labrador tea/horsetail Sw-Sb	Moderate	20
i1 - treed bog	High	15
i2 - shrubby bog	High	15
j1 - treed poor fen	High	15
j2 - shrubby poor fen	Moderate	20
k1 - treed rich fen	Moderate	20
k2 - shrubby rich fen	Moderate	20
k3 - graminoid rich fen	Moderate	20
l1 – marsh	Low	>20

4.2 Wetlands

4.2.1 Field Survey Methods

Wetland sampling was incorporated into the general vegetative resources survey and therefore done at the same time as upland sampling. Field survey methods followed the methods outlined in Section 4.1.2. All plots within wetlands were classified using the Beckingham ecosite system (Beckingham and Archibald 1996) and some plots were classified using the Alberta Wetlands Inventory system in the field. The Beckingham system recognizes four wetland ecosites – bog, poor fen, rich fen, and marsh (i, j, k and l ecosites, respectively).

4.2.2 Post-Survey Methods

4.2.2.1 Alberta Wetland Inventory Standards

The Alberta Wetland Inventory Standards (Halsey and Vitt 1997) classifies wetlands by incorporating the NWWG standards (1988) into a slightly more simplified design. The Alberta Wetland Inventory Standards (AWIS) includes four levels:

- Wetland class (NWWG 1988);
- Vegetation modifier (i.e. forested, wooded, open);
- Wetland complex landform modifier (permafrost, patterning); and
- Local landform/vegetation modifier.

Classes and modifiers are denoted with a single letter, providing a four-letter code for each wetland type (Table 4-7). This system is designed for easy classification based on aerial photo interpretation and does not consider many edaphic or geomorphologic characteristics. A total of 15 types of wetlands are common to Alberta based on the above criteria (Halsey and Vitt 1997).

The ecosite map was used to produce the map of AWIS wetlands. Any polygon that had an i, j, k, or l ecosite phase as part of its classification (even if it was not the dominant phase) was classified using AWIS. As well, some polygons that had a g1 or h1 ecosite phase according to the Beckingham system were also classified using the Alberta Wetland Inventory Standards. This is because some sites classified as g1 and h1 could be classified as wetlands based on their moisture regime (using the Beckingham system, a moisture regime of hygric-hydric), peat depth, or hydrophytic vegetation (e.g., bog birch in the g1 ecosite phase). Therefore, a field visit is required to properly identify this wetland type, and as such, polygons labeled with a g1 or h1 were included in the AWIS mapping only if they had plot data or were obviously wetland areas based on topography.

The ecosite level in the Beckingham and Archibald hierarchical ecological classification system provided information to determine Wetland Class. Ecosite phases were used to determine the AWIS Vegetation Modifier, and aerial photos were used to determine AWIS Wetland Complex Landform Modifier and the Local Landform Modifier.

Table 4-7: Alberta Wetland Inventory Standards Classification System[1]

Level	Criteria	Code
Wetland Class	Bog	B
	Fen	F
	Swamp	S
	Marsh	M
	Shallow Open Water	W
Vegetation Modifier	Forested: closed canopy >70% tree coverage	F
	Wooded: open canopy >6-70% tree coverage	T
	Open: shrubs, sedges, graminoids, herbs, etc. <6% tree cover	O
Wetland Complex Landform Modifier	Permafrost is present	X
	Patterning is present	P
	Permafrost or patterning is not present	N
Local Landform Modifier	Collapse scar	C
	Internal lawn with islands of forested peat plateau	R
	Internal lawns	I
	No internal lawns are present	N
	Shrub cover >25% when tree cover <u><</u>6%	S
	Graminoid dominated with shrub cover <u><</u>25% and tree cover <u><</u>6%	G

[1] From Halsey and Vitt 1997.

4.2.3 Quality Assurance and Quality Control

Quality assurance and control methods used in the collection of field data included:

- Selecting sites across the study areas to ensure equal representation of different types of wetlands;
- Selecting sites in homogenous vegetation to ensure accurate ecosite phase and wetland class designations;
- Reviewing data sheets daily to make certain they were complete, legible, and accurate;
- Reviewing plant specimens collected daily to ensure proper labeling and identification.

Quality assurance and control methods used in the office for data processing included:

- Incorporating other baseline wetland data and reports from adjacent areas within the RSA;
- Ensuring field data were entered properly into the database through quality checks and queries;
- Using aerial photographs to supplement field ecosite phase and wetland class designations in the creation of maps.

4.2.4 Data Analysis

Field data from sample plots were entered into a database for summary and analysis. This information was reviewed, and digitized to confirm AWIS classifications made from aerial photo interpretation and to aid in final map production (Section 4.1.2). The area of each AWIS wetland type within the study areas was calculated. In polygons with both upland and wetland components, only the percentage of the polygon that was wetland was used to calculate area. A map was then produced showing the distribution of each AWIS wetland type within the LSA and RSA.

4.3 Rare Plants

4.3.1 Pre-field Data Processing and Stratification

Prior to the field survey, a list of potential rare plants and rare plant communities that could likely be found in the RSA was acquired from Alberta's Conservation Data Center – the Alberta Natural Heritage Information Centre (ANHIC 2010). Results of the ANHIC database query are included in Appendix 7.

Areas that were most likely to support rare plant species or rare communities were selected from the interpreted maps, and sample plots were then selected to incorporate the broadest range of habitats within the PF and LSA.

4.3.2 Data Collection

The rare plant and rare plant community survey was performed in accordance with ANPC guidelines (2000a). The data collection protocols used for this survey followed those outlined in the Ecological Land Survey Site Description Manual (Alberta Environmental Protection 1994) and the ANPC (2000a) guidelines. All rare plant plots were marked at the center with flagging tape denoting the plot number, date, and surveyor initials. Plot location was recorded at plot center with a GPS unit and one photograph of a representative area of the site was taken. Helicopter access was required in many cases because of the remoteness of some sample locations and the wet terrain.

Within the PF and LSA, a total of 240 rare plant plots were investigated between 2006 and 2009, using meander searches and some patterned searches. The distribution of survey plots is presented in Figure 4-1.

A meander search is when the surveyor walks in a spiral pattern in order to cover a greater area more thoroughly. This method starts at the centre of the plot. The surveyor then searches in a spiral pattern around the centre point until no more new plant species are found or a new ecosite phase (habitat) is entered. Unique or special landscape features such as microhabitats, ephemeral habitats, wet areas or transition zones were given special attention. These areas are important habitats for rare plants. Rare plants and rare plant communities are usually closely linked with soil moisture, nutrient levels, and substrate type. Surveyors were looking for any special, unique or rare plant communities while performing the rare plant survey.

While moving from one plot to another, surveyors scanned the area for rare or unique plants and communities. If a plant could not be identified in the field, a sample (voucher) was collected as specified in the Native Plant Collection and Use Guidelines (ANPC 2006). Rare plant vouchers were collected only if its removal would not lead to an immediate population loss greater than 4%. This was done to ensure that the potential for future plant propagation was not compromised. Vouchers collected included the minimum amount of material (leaf, seeds, twigs) needed to ensure proper identification. Whole plants were collected only if the population was large enough. In the case where there were insufficient plants to allow for collection, photographs, detailed descriptions, and the collection of key plant parts allowed for subsequent identifications. Specimens for identification were preserved by pressing vascular plants, and by air-drying mosses and lichens in paper bags.

4.3.3 Post-survey Methods

Rare plant species within the project area were mapped using the UTM coordinates from the GPS waypoints. Bryophyte and lichen species were sent for taxonomic validation by outside professional taxonomists and any rare vascular plants identified in-house were then sent to experts for confirmation. All plant names in this report follow Natureserve (2009).

4.3.4 Quality Assurance and Quality Control

4.3.4.1 Field Surveys

Quality assurance and control methods used in the collection of field data included:

- Compiling a list of potential rare plant species and communities and their habitats before field surveys, as well as obtaining the official ANHIC lists;
- Selecting sites in unique habitats or ecotones to ensure places that are likely to harbor rare plants are visited;
- Following accepted protocols (e.g. ANPC collection guidelines) when a rare plant was encountered;
- Reviewing data sheets daily to make certain they were complete, legible, and accurate;
- Reviewing plant specimens collected daily to ensure proper labeling and identification, if species is known; and
- Reviewing suspected rare plants or rare plant communities found by other surveyors to increase awareness.

4.3.4.2 Office

Quality assurance and control methods used in the office for data processing included:

- Incorporating other baseline rare plant reports from adjacent areas within the cumulative effects area;
- Ensuring field data were entered properly into the database through quality checks and queries;
- Sending plant specimens that were thought to be rare or were difficult to confirm to a qualified plant taxonomist; and
- Assuring plant species names were the most up to date and accurate.

4.3.5 Data Analysis

Scientific and common plant species names follow the conventions used in the current ANHIC vascular, bryophyte and lichen element lists (ANHIC 2010). Once compiled into database format, the ANHIC rank and current tracking and watch list status for each species found in the survey was determined (ANHIC 2010). Species found to be on the tracking or watch lists were described in detail and their location was mapped. The Alberta Sustainable Resource Department (ASRD) *The Status of Alberta Species* (2005) was also reviewed for the status of tracked species. Along with basic ecological requirements, detailed species descriptions were prepared and include physical description, habitat requirements, phenology and reproductive methods, range in North America and/or the world, status in adjoining jurisdictions (where available), vegetation type where the species was found.

When not found in the literature, common names for bryophytes and lichens were assigned to species using the Nature Navigator (2004) database.

4.4 Biodiversity

4.4.1 Species diversity

To assess species level biodiversity, the biodiversity potential of each ecosite phase will be used. Ecosite phase biodiversity potential incorporates the species richness (number of species), number of rare plants, and the number of unique species (species that occurred in only one ecosite phase). Also, plant species are classified into groups such as vascular or non-vascular species.

4.4.2 Community diversity

Community level biodiversity will be assessed by looking at project effects on ecosite phases within the LSA and RSA. Unlike the species level assessment that focuses on species within each ecosite phase, the community level assessment focuses on the diversity of ecosite phases in the Project study areas.

4.4.3 Landscape diversity

To assess biodiversity at the landscape level, the amount of fragmentation is considered including effects on the size, shape, number, and distribution of patches (ecosite phases) within the LSA and RSA. The potential Project effects on old growth forests are also included in the assessment.

4.4.4 Measures of Biodiversity

To calculate measures of biodiversity, sample plots located within each identified ecosite phase were treated as replicates and assumed to reflect the average and range in species richness and abundance for the whole community. Plot data provides the required information for calculation of diversity and evenness.

Biodiversity measures of species richness, diversity and evenness were performed using the Statistical Analysis Software (SAS). Species richness *(S)* was calculated as a count of the species encountered. Diversity (H) was calculated using the Shannon's diversity index with plant percent cover as abundance and applying by following formula (MacArthur and MacArthur 1961):

$$[1] \qquad H = -\text{ sum }(Pi * \ln(Pi))$$

Where: H = Shannon's diversity index; *Pi* = proportion of individuals of species *i* relative to the total number of individuals of all species; and ln*(Pi)* = the natural logarithm of *Pi.*

Evenness *(J)* was calculated as the function of richness and diversity by applying the formula:

$$[2] \qquad J = H / \ln(S)$$

Where *H* is the Shannon's diversity index and ln*(S)* is the natural logarithm of species richness.

The biodiversity potential for each ecosite phase has been calculated from data collected from 1,094 survey sites within the Boreal Mixedwood ecological area of the Boreal Forest Natural Region. This data is included in the FloraLogix™ model developed by GDC. The model is designed to predict the biodiversity index of vascular and non-vascular plants separately, so that results of the modeling will better match model user's targets as well as increase the association linkage between biodiversity and plant community.

A spatial pattern analysis program (FRAGSTATS, McGarigal and Marks 1995) was used to quantify landscape structure. FRAGSTATS users can quantify the spatial distribution of patches within a landscape by delineating patches on maps into polygons. Patches are disconnected or detached areas with homogeneous environmental conditions that are dissimilar from the surrounding landscape (McGarigal and Marks 1995). Patch types are defined by ecosite phase for the LSA and RSA. Vegetation data were converted from vector to raster format for use in FRAGSTATS, resulting in minor changes to patch number and sizes of individual patches.

FRAGSTATS computes three groups of metrics, and provides several statistics used to analyze number of patches, patch size, patch shape and extent, and isolation and distribution of the patches within the LSA and RSA. The four groups of metrics address each patch in the mosaic; each patch type or class (ecosite phase) in the mosaic; and the landscape as a whole.

The following metrics were calculated at the class level:

- number,
- class area (ha),
- average size (ha),
- perimeter length (m),
- perimeter area ratio (m/ha),
- distance between like patches (nearest neighbor) (m).

At the landscape level, the following metrics were calculated:

- means for all of the class level metrics,
- richness,
- evenness,
- diversity (Shannon's).

5 BASELINE CASE

5.1 Vegetation

5.1.1 Local Study Area

5.1.1.1 Wildfires

A large portion of the PF, LSA and RSA has been recently (1995) burned by wildfire (97%, 98% and 95%, respectively), and much of the vegetation is in early successional stages. ELC mapping following fire presents many challenges. Species present in young regenerating stands may not be representative of species that will characterize the stands at maturity. In particular, species/site mismatches may occur as conditions in the years immediately after fire may be quite different and allow for invasive and opportunistic species to temporarily establish. A frequently encountered example of post-fire species/site mismatch is jack pine that establishes on burned bogs and fens. Moist moss on bogs and fens is a good seedbed and pine will readily establish from seed dispersed after the fire, however, though jack pine is highly adapted to fire as well as to dry nutrient-poor conditions, the trees will not survive until maturity, rarely getting larger than pole size, due to the high water table.

Ecosite classification is based primarily on site conditions as represented by the moisture (xeric to hydric, 1-9) and nutrient (very poor to very rich, A-E) regimes. Ecosite is rarely altered by wildfire over the long term. However, short term increases in moisture levels are common on forested sites when the disturbance is severe enough to remove the precipitation intercepting vegetation as well as reduce the amount of water loss through transpiration. This increase in moisture can result in the development of a plant community that is entirely different from the mature forest that was consumed by the fire. Succession may then be slowed as competition prevents ingress of other species, particularly if grasses such as *Calamagrostis canadensis* capture the site following fire.

Ecosite phase includes both the site conditions (ecosite) and the dominant vegetation in the tallest layer (typically trees). When field data (plots) are available, interpretation of the ecosite phase for recently burned areas can be made based on both site characteristics (e.g., moisture regime and nutrient regime) and the species present. Interpretation of future ecosite includes species tolerances (e.g., moisture, nutrients, shade) and other important life history traits (e.g., longevity, regeneration method). A knowledgeable field ecologist can then predict the likely ecosite phase at maturity even when it is not currently present. Without field data, interpretation of ecosite phase becomes much more difficult.

The history of wildfires in the LSA and RSA is presented in Figure 1-2.

5.1.1.2 Species Distributions

In total, 635 plant species were found in the LSA. Of these, 329 were vascular plants, 135 were mosses and liverworts and 167 were lichens. For a complete list of the flora identified in the LSA, refer to Appendix 2.

5.1.1.3 Ecosite Phases

Twenty-four ecosite phases were mapped within the study areas. Large water bodies or features were also mapped (lakes, ponds, beaver dams) and these along with disturbed areas were classified with AVI codes. Table 5-1 shows the amount of each ecosite phase and AVI polygon identified and Figure 5-1 shows their distribution.

Upland communities occupy 31.2% (4,801.9 ha) of the LSA, and lowland communities occupy 64.4% (9,900.2 ha). Existing Connacher facilities (Pod One and Algar) occupy 1.4% (217.6 ha) of the LSA. Industrial and anthropogenic disturbances, including well pads, roads, borrow pits, highway 63, clearings and pipelines, cover 2.4% (371.4 ha) of the LSA, and water (flooded areas and lakes) occupies 0.5% (80.3 ha). The PF (520.8 ha) accounts for 3.4% of the LSA.

The c1 and i2 ecosite phases occupy the largest portion of the LSA (21.8% and 20.1%, respectively), whereas the b3, b4, e3 and l1 ecosite phases occupy the smallest area (all <0.1%;). Fourteen of the 24 ecosite phases occupy less than 1% of the LSA (Table 5-1), and these are considered to be of limited distribution, collectively representing 2.9% of the LSA (441.3 ha). Ecosite phases d1 and d2, while limited in distribution in the LSA, are not limited in the RSA. Lakes and flooded land units also occupy less than 1% of the LSA.

A description of each ecosite phase mapped within the LSA is included in Appendix 3 and uses the approach of Beckingham and Archibald (1996).

Table 5-1: Distribution of ecosite phases in the PF, LSA and RSA.

Ecosite phase	Total area in PF (ha)[1]	Percent of PF (%)	Total area in LSA (ha)	Percent of LSA (%)	Total area in RSA (ha)	Percent of RSA (%)
b1 - blueberry Pj-Aw	32.4	6.2	1,081.9	7.0	2,057.5	3.6
b2 - blueberry Aw(Bw)	0.0	0.0	18.9	0.1	96.4	0.2
b3 – blueberry Aw-Sw	0.0	0.0	3.1	<0.1	3.1	<0.1
b4 – blueberry Sw-Pj	0.0	0.0	6.1	<0.1	20.1	<0.1
c1 - Labrador tea-mesic Pj-Sb	146.6	28.1	3,357.8	21.8	10,824.1	18.8
d1 - low-bush cranberry Aw	0.6	0.1	74.6	0.5	1,547.8	2.7
d2 - low bush cranberry Aw-Sw	2.0	0.4	92.2	0.6	561.8	1.0
d3 - low bush cranberry Sw	4.3	0.8	82.3	0.5	313.4	0.5
e1 - dogwood Pb-Aw	0.0	0.0	16.6	0.1	52.8	0.1
e2 - dogwood Pb-Sw	0.0	0.0	20.4	0.1	37.3	0.1
e3 - dogwood Sw	0.0	0.0	7.6	<0.1	10.6	<0.1
f1 - horsetail Pb-Aw	0.0	0.0	11.9	0.1	66.2	0.1
f2 -horsetail Pb-Sw	0.0	0.0	17.6	0.1	31.6	0.1
f3 - horsetail Sw	0.0	0.0	10.9	0.1	11.2	<0.1
g1 - Labrador tea –subhygric Sb-Pj	132.9	25.5	2,355.7	15.3	6,774.7	11.8
h1 - Labrador tea/horsetail Sw-Sb	2.5	0.5	73.1	0.5	253.0	0.4
i1 - treed bog	50.3	9.7	1,002.8	6.5	3,939.3	6.9
i2 - shrubby bog	78.0	15.0	3,090.0	20.1	11,610.8	20.2
j1 - treed poor fen	9.2	1.8	501.9	3.3	2,827.8	4.9
j2 - shrubby poor fen	27.4	5.3	1,318.1	8.6	6,911.4	12.0
k1 - treed rich fen	2.9	0.5	413.8	2.7	2,155.4	3.8
k2 - shrubby rich fen	19.4	3.7	928.4	6.0	4,222.9	7.3
k3 - graminoid rich fen	2.8	0.5	210.5	1.4	1,841.6	3.2
l1 - marsh	0.1	0.0	6.0	<0.1	18.2	<0.1
Flooded	0.0	0.0	4.9	<0.1	12.6	<0.1
Ponds, Lakes	0.0	0.0	75.4	0.5	226.7	0.4
Pod One & Algar	0.0	0.0	217.6	1.4	217.6	0.4
AIG - Gravel and borrow pits	0.0	0.0	0.5	<0.1	42.3	0.1
AIH - Permanent right of way, roads, highways	0.3	0.1	76.3	0.5	196.9	0.3
AII - Industrial sites	0.2	0.0	1.7	<0.1	1.7	<0.1
CIP - Vegetated pipelines, transmission lines, airstrips	0.2	0.0	170.0	1.1	377.9	0.7
CIU - Unknown clearing	4.0	0.8	18.3	0.1	29.9	0.1
CIW - Vegetated well sites	4.9	0.9	104.6	0.7	163.8	0.3
Total	**520.8**	**100.0**	**15,371.4**	**100.0**	**57,458.4**	**100.0**

[1] – Total area in PF is a summary of all three Project phases together.

5.1.1.4 Rare Plant Potential

Rare plant potential by ecosite phase is summarized in Table 5-2. The sites with the highest rare plant potential are the d1, d2, g1, i1, i2, j1, k1, and k2 phases, and collectively occupy 55% of the LSA. The ecosite phases with the lowest rare plant potential are the b3, b4, and l1 phases. These ecosites phases collectively represent <0.1% of the LSA.

Rare plants that were observed in the LSA are described in Section 5.3.

Table 5-2: Rare Plant Potential by Ecosite Phase

Ecosite phase	Number of rare species in the LSA	Rare Plant Potential
b1 - blueberry Pj-Aw	4	L
b2 - blueberry Aw(Bw)	8	L
b3 – blueberry Aw-Sw	-	VL
b4 – blueberry Sw-Pj	-	VL
c1 - Labrador tea-mesic Pj-Sb	12	H
d1 - low-bush cranberry Aw	6	VH
d2 - low bush cranberry Aw-Sw	2	VH
d3 - low bush cranberry Sw	2	H
e1 - dogwood Pb-Aw	7	M
e2 - dogwood Pb-Sw	2	L
e3 - dogwood Sw	-	L
f1 - horsetail Pb-Aw	2	M
f2 -horsetail Pb-Sw	1	M
f3 - horsetail Sw	2	L
g1 - Labrador tea –subhygric Sb-Pj	8	VH
h1 - Labrador tea/horsetail Sw-Sb	5	H
i1 - treed bog	14	VH
i2 - shrubby bog	9	VH
j1 - treed poor fen	13	VH
j2 - shrubby poor fen	8	H
k1 - treed rich fen	9	VH
k2 - shrubby rich fen	14	VH
k3 - graminoid rich fen	6	M
l1 - marsh	3	VL

Species that do not appear on ANHIC's All Element Lists, but were observed in the LSA are assumed to be rare and are included in the number of rare species found in the LSA (Section 5.3).

5.1.1.5 Non-native and Invasive Plants

The baseline field surveys identified 61 occurrences of non-native and invasive species (Government of Alberta 2001) within the LSA (Appendix 4). These are designated agronomic invasive, nuisance, and noxious species (ANPC 2000b), and many were observed in areas associated with existing development (Highway 63, well pads, access roads and seismic lines). These occurrences comprised the following 16 species:

- **Noxious weeds**: *Chrysanthemum leucanthemum*; *Cirsium arvense*; and *Sonchus arvensis*;
- **Nuisance weeds**: *Erysimum cheiranthoides*; *Potentilla norvegica*; and *Taraxacum officinale*; and
- **Agronomic invasive species**: *Agropyron pectiniforme*; *Bromus inermis*; *Festuca rubra*; *Glyceria grandis*; *Medicago sativa*; *Melilotus alba*; *Phalaris arundinacea; Phleum pratense*; *Trifolium hybridum*; and *Trifolium pratense*.
- **Restricted weeds:** No restricted weeds were found in the LSA.

5.1.1.6 Forestry Resource

Using the TDA tables and assigned cover classes (Section 4.1.5.3), the volume of each commercialism class (stand type) was determined (Table 5-3) by commercialism class for the PF, LSA, and RSA. Commercialism classes are Coniferous, Coniferous-Deciduous, Deciduous-Coniferous, and Deciduous (defined in Table 4-3). Any stand with average tree height 12 m tall or greater and assigned a timber productivity rating (TPR) of good (G), medium (M), or fair (F) was considered merchantable, and stands less than 12 m tall or rated unproductive (U) were considered unmerchantable. The total volume of timber in the LSA is 98,609.4 m^3, and 58% of that is merchantable (56,788 m^3).

The total area of forested land was determined using the polygon area given by the AVI data. Forested areas (both productive and unproductive) represent 74% of the LSA (Table 5-4). Productive forested land represents 68% of the LSA and non-productive forested land represents 6%. Non-forested land occupies the remainder of the total area (26%) and is a combination of anthropogenic features (roads, power lines, pipelines, railroads, wells, facilities), lakes and flooded areas, and areas with shrubby or graminoid vegetation. Timber volume in the RSA is described in Section 5.1.2.3.

While the area of productive land in the LSA is relatively high (68%), the merchantable timber volume on this productive land is relatively low (56,788 m^3) and reflects the young age of regenerating stands since the 1995 wildfire.

Table 5-3: Merchantable and non-merchantable timber volumes

Timber Volume (m3)					
Timber Productivity Rating	Coniferous	Coniferous - Deciduous	Deciduous - Coniferous	Deciduous	Total
PF					
Good	457.7	28.7	0.0	190.1	676.5
Medium	2,018.5	0.0	12.5	668.3	2,699.3
Fair	60.8	0.0	0.0	0.0	60.8
Unproductive	129.2	0.0	0.0	0.0	129.2
Total volume	2666.2	28.7	12.5	858.4	3565.8
Total merchantable	1,949.2	0.0	12.5	752.3	2,714.0
LSA					
Good	13,927.1	1,113.6	1,572.8	7,887.2	24,500.7
Medium	48,948.7	5,771.3	1,016.5	6,134.7	61,871.2
Fair	5,428.9	0.0	0.0	0.0	5,428.9
Unproductive	6,808.6	0.0	0.0	0.0	6,808.6
Total volume	75,113.3	6,884.9	2,589.3	14,021.9	98,609.4
Total merchantable	41,058.3	2,355.1	2,589.3	10,785.3	56,788.0
RSA					
Good	56,123.6	5,902.4	7,028.1	41,576.3	110,630.4
Medium	226,730.2	9,608.5	4,434.8	16,350.1	257,123.6
Fair	43,936.3	0.0	57.3	233.4	44,227.0
Unproductive	30,918.5	134.6	0.0	0.0	31,053.1
Total volume	357,708.6	15,645.5	11,520.2	58,159.8	443,034.1
Total merchantable	199,072.4	12,144.4	11,520.2	57,722.8	280,459.8

Table 5-4: Timber Productivity Rating (TPR) for the PF, LSA, and RSA

TPR	Area (ha)		
	PF	LSA	RSA
Good	328.5	7,194.8	15,223.9
Moderate	73.6	2,744.3	11,379.0
Fair	6.3	483.9	3,493.2
Unproductive	18.8	895.8	4,586.9
Non-productive	18.8	895.8	4,586.9
Productive	408.5	10,423.0	30,096.0
Non-forested	93.5	4,052.6	22,775.5
Total	**520.8**	**15,371.4**	**57,458.5**

The volume of timber to be removed by leading species stand type and by year is presented in Table 5-5. The year of removal is based on the first year of construction of each phase of the Project. Standing volumes are relatively low due wildfire that consumed the majority of the LSA and RSA. The dominant species found within the PF is black spruce, followed by tamarack, paper birch, white spruce, and trembling aspen. The values shown are for total volume (merchantable and unmerchantable). The total volume of merchantable timber that is to be removed from the PF is 2,714.0 m^3. Merchantable species, particularly black spruce and jack pine, will be re-established at Project closure and as a result the impact on Annual Allowable Cut (AAC) will be minimal and confined to loss of growth of within the PF only. Currently, it is estimated that 722.6 m^3 of unsalvageable timber (all species combined on productive land) is present within the PF and is considered too small for commercial salvage.

Table 5-5: Lead species stand volumes

Species	Volume of Timber (m^3)			
	Year 1 (Phase I)	Year 10 (Phase II)	Year 18 (Phase III)	Total
Black Spruce	147.3	263.9	825.2	1,236.4
Tamarack	38.7	57.2	87.3	183.2
White Spruce	3.9	9.8	388.4	402.1
Paper Birch	10.1	-	560.3	570.4
Jack Pine	-	839.5	49.2	888.7
Trembling Aspen	-	87.9	197.1	285.0
Total	**200.0**	**1,258.3**	**2,107.5**	**3,565.8**

5.1.1.7 Old Growth Forests

The area represented by old growth forests in the LSA is 30.7 ha. These areas are composed of small, scattered remnant patches of aspen, black spruce, tamarack, and birch that were not removed by either the 1995 fire or other disturbances. Figure 5-2 shows the distribution of old growth stands in the LSA.

Most of the vegetated areas in the LSA are in early successional stages resulting from the frequent wildfires in the region (Figure 1-2). Fire continues to be the dominant disturbance mechanism in the boreal forest, and the potential for ecosite phases to support old growth forests in the LSA is assessed after accounting for variations in frequency, intensity, and landscape patterns that are generated after fire. Deciduous stands have a longer fire return interval than pine or spruce, and burn with lower frequency as they do not support the stand replacing canopy fires typical when pine and spruce stands burn. Mixed deciduous – white spruce stands have a low probability of burning until the proportion of spruce reaches 50%, and then white spruce dominant stands would need to escape fire for very long periods of time to reach old growth age (Schneider 2002). Also, for pine stands in the boreal forest, the fire return interval is less than rotation age, and pine often does not survive to the age at which they are considered old growth.

Estimates of the rate of burning and the understanding of forest regeneration are limited for predicting the patterns of old growth that may arise from specific fire regimes in the boreal forest (Schneider 2002). Climate change models are predicting bigger, more frequent and more severe fires with longer fire seasons in Canada (Davis and Crosby 2007). Therefore, there is a level of uncertainty that is inherent when predicting the potential for old growth forests to develop in the boreal forest. The potential for ecosite phases to support old growth forests has been assessed by accounting for the boreal forest disturbance regime, including wildfire and predictions of climate change, and the experience of vegetation ecologists. The old growth potential and the associated level of confidence in the prediction is assigned with rankings of “Low”, “Moderate” and “High”, and these are presented in Table 5-6.

Ecosite phases d1 and e1 both had high old growth potential, predicted with high confidence, and these areas occupy 0.6% of the LSA (91.2 ha). Ecosite phases with moderate potential and high confidence (b2, f3, j1, k1) occupy 6.2% of the LSA (945.5 ha).

Table 5-6: Old growth potential by ecosite phase

Ecosite phase[1]	Old Growth Potential	Confidence
b1 - blueberry Pj-Aw	Moderate	Moderate
b2 - blueberry Aw(Bw)	Moderate	High
b3 – blueberry Aw-Sw	Moderate	Low
b4 – blueberry Sw-Pj	Low	High
c1 - Labrador tea-mesic Pj-Sb	Low	High
d1 - low-bush cranberry Aw	High	High
d2 - low bush cranberry Aw-Sw	Moderate	Moderate
d3 - low bush cranberry Sw	Low	High
e1 - dogwood Pb-Aw	High	High
e2 - dogwood Pb-Sw	Moderate	Moderate
e3 - dogwood Sw	Low	High
f1 - horsetail Pb-Aw	High	Low
f2 -horsetail Pb-Sw	Moderate	Low
f3 - horsetail Sw	Moderate	High
g1 - Labrador tea –subhygric Sb-Pj	Moderate	Low
h1 - Labrador tea/horsetail Sw-Sb	Low	Low
i1 - treed bog	Low	High
i2 - shrubby bog	Low	High
j1 - treed poor fen	Moderate	High
j2 - shrubby poor fen	Low	High
k1 - treed rich fen	Moderate	High
k2 - shrubby rich fen	Low	High
k3 - graminoid rich fen	n/a[2]	High
l1 – marsh	n/a[2]	High

[1] Coniferous stands, particularly mixed stands, may revert to deciduous dominance after fire (Cumming 2001).
[2] Ecosite phase is not forested.

5.1.1.8 Traditional Ecological Knowledge and Land Use

Forty-nine vascular plant and lichen species with traditional value were identified during Aboriginal consultation for the proposed Project and a TLUS conducted for lands north of the LSA (Axys 2000). The potential ecosites that these plants could be found in are presented in Appendix 5. Ecosite phases and their potential to support traditionally used plants are presented in Table 5-7. The number of traditionally used plants found in each ecosite phase within the LSA is also presented.

Table 5-7: Traditional plant potential

Ecosite phase	Number of Plants Potentially Present	Number of Plants Found in LSA	Traditional Plant Potential
b1 - blueberry Pj-Aw	18	18	Moderate
b2 - blueberry Aw(Bw)	19	9	Moderate
b3 – blueberry Aw-Sw	17	-[1]	Moderate
b4 – blueberry Sw-Pj	15	-[1]	Low
c1 - Labrador tea-mesic Pj-Sb	16	18	Moderate
d1 - low-bush cranberry Aw	27	19	High
d2 - low bush cranberry Aw-Sw	29	22	High
d3 - low bush cranberry Sw	26	11	High
e1 - dogwood Pb-Aw	28	19	High
e2 - dogwood Pb-Sw	29	10	High
e3 - dogwood Sw	27	-[1]	High
f1 - horsetail Pb-Aw	25	7	Moderate
f2 -horsetail Pb-Sw	24	18	Moderate
f3 - horsetail Sw	24	10	Moderate
g1 - Labrador tea –subhygric Sb-Pj	24	11	Moderate
h1 - Labrador tea/horsetail Sw-Sb	22	19	Moderate
i1 - treed bog	13	12	Low
i2 - shrubby bog	16	12	Moderate
j1 - treed poor fen	19	11	Moderate
j2 - shrubby poor fen	18	13	Moderate
k1 - treed rich fen	22	11	Moderate
k2 - shrubby rich fen	23	17	Moderate
k3 - graminoid rich fen	24	6	Moderate
l1 - marsh	21	17	Moderate

[1] - ecosite phase was not surveyed.

Ecosite phases d1, d2, d3, e1, e2, and e3 were all found to have high potential to support traditionally used plants, and together occupy 1.8% of the LSA (294 ha).

In this assessment, all listed traditionally used species are considered equal in importance and the measurements determined for each ecosite phase are dependent only on presence within ecosite phases (i.e., the frequency of occurrence). There has been no attempt to attach relative importance to individual species. However, as a result of the Aboriginal consultation, edible berry plants have been identified as having higher importance and can be used to indicate which ecosite phases may have a greater value for traditional plant use. Although many of the plants identified can be found in several ecosite phases (Appendix 5), the probability of finding these species in abundance will be highest where they are considered characteristic of the ecosite phase (not incidental occurrence). Characteristic species are those with higher prominence values according to Beckingham and Archibald (1996). Table 5-8 presents a list of berry plants found in the LSA and the characteristic ecosite phases they are found within.

Table 5-8: Berry species and characteristic ecosite phases.

Common Name	Scientific Name	Characteristic Ecosites
blueberry	*Vaccinium myrtilloides*	a1, b1, b2, b3, b4, c1, g1
bog cranberry	*Vaccinium vitis-idaea, Oxycoccus microcarpus*	b1, b2, b3, b4, c1, g1, i1, i2, j1, j2
chokecherry	*Prunus virginiana*	b1, b2, b3, b4, d1, d2, d3
cloudberry	*Rubus chamaemorus*	i1, i2, j1, j2
currants and gooseberry	*Ribes spp.*	e1, e2, e3, f1, f2, f3, g1, h1
hazelnut[1]	*Corylus cornutta*	d1, d2
low-bush cranberry	*Viburnum edule*	d1, d2, d3, e1, e2
pin cherry	*Prunus pensylvanica*	b1, b2, b3, d1, d2, f1, f2
Saskatoon	*Amelanchier alnifolia*	d1, d2, e1
wild raspberry	*Rubus idaeus*	d1, d2, e1, e2, e3, f1, f2
wild strawberry	*Fragaria virginiana*	d1, d2, d3, e1, e2, e3, f1, f2, f3

[1] – Hazelnut is not a berry plant however it was identified as a plant of interest during the consultation process.

While ecosite phases b4 and i2 have been classified as having low potential to support traditional plant species, both are characteristic habitats of valued berry plants. Rich fen ecosite phases (k1, k2, k3) and marsh (l1) do not support berry plants.

5.1.2 Regional Study Area

5.1.2.1 Ecosite Phases

Upland areas account for 27.2% of the RSA (15,633.8 ha), and lowland areas occupy 70.6% (40,555.1 ha) (Table 5-1, Figure 5-1). Industrial and anthropogenic disturbances, including well pads, roads, borrow pits, Highway 63, clearings and pipelines, cover 1.4% (812.6 ha) of the RSA, and water (flooded areas and lakes) occupies 0.4% (239.3 ha). Existing Connacher facilities (Pod One and Algar) occupy 0.4% (217.6 ha) of the RSA. The PF (all phases combined), Pod One and Algar facilities, and other existing disturbances account for 2.7% of the RSA (1551 ha).

Shrubby bog (i2) and Labrador tea-mesic Jack pine-black spruce (c1) ecosite phases occupy the largest area in the RSA (20.2% and 18.8%, respectively). Blueberry aspen-white spruce (b3) and dogwood white spruce (e3) ecosite phases occupy the least area in the RSA (0.01% and 0.02%, respectively) and there are twelve ecosite phases of limited distribution (<1 %) in the RSA (Table 5-1). All of the ecosites found with limited distribution within the RSA, were also limited in the LSA. Ecosite phases d1 and d2, which were limited in distribution in the LSA, are not restricted in the RSA.

5.1.2.2 Rare Plant Potential

Rare plant potential by ecosite phase is summarized in Table 5-2 (Section 5.1.1.4). The sites with the highest rare plant potential are the d1, d2, g1, i1, i2, j1, and k1 phases, and collectively occupy 51.3% of the RSA. The ecosite phases with the lowest rare plant potential are the b3, b4, and l1 phases. These ecosites phases collectively represent <0.1% of the LSA.

5.1.2.3 Forestry Resource

The dominant species found in the RSA is black spruce, followed by jack pine, tamarack, trembling aspen, white spruce, paper birch and a very small amount of balsam poplar. The total volume of timber within the RSA is 443,034.1 m^3, and 81 % is coniferous, 13 % is deciduous, and 6 % is a mixture of both. Of the total volume, the volume of merchantable timber in the RSA is 280,459.8 m^3.

The volume of each stand type was determined and the volume of each species cover class by TPR is presented in Table 5-4 (Section 5.1.1.6). Forested areas (both productive and unproductive) represent 60 % of the RSA. Productive forested land represents 52 % of the RSA and non-productive forested land represents 8 %. Non-forested land occupies 40 %.

Merchantable timber volume on productive land in the RSA is relatively low (280,459.8 m^3) and reflects the young age of regenerating stands since the 1995 wildfire.

5.1.2.4 Old Growth Forests

The area represented by old growth forests in the RSA is 257 ha. These areas are generally composed of small, scattered remnant patches of aspen, black spruce, tamarack and birch that were not removed by either wildfire or other disturbances. Figure 5-2 shows the distribution of old growth stands in the RSA.

The proportion of the RSA that has high old growth potential predicted with high confidence (ecosite phases d1 and e1) is 2.8%. Ecosite phases with moderate old growth potential and high confidence (b2, f3, j1, k1) occupy 8.9% of the RSA.

The current forest age distribution within the RSA is shown in Figure 5-4. Approximately 73% of forested lands are 16 years old or younger due to the 1995 wildfire. In total the Young forest class covers more than 86% of forested lands within the RSA.

The current age class distribution compared to the expected distribution (from Andison 2005) is shown in Figure 5-4. The overwhelming effect that recent wildfire had on forest age class distribution within the RSA (and LSA) is apparent by the shifting of forests into the Young age class, decreasing the proportion of the remaining classes. The deviation from the modeled distribution (expected) demonstrates that at the Baseline Case, old growth in the RSA (and LSA) has essentially been removed from the study area.

5.1.2.5 Traditional Ecological Knowledge and Land Use

The area of the RSA containing ecosite phases with high potential to support traditionally used plants is 4.4% (Section 5.1.1.8).

5.1.2.6 Potential Acid Input and Nitrogen Deposition

Baseline nitrogen deposition levels inside the RSA are expected to reach a maximum of 2 kg ha^{-1} yr^{--1}. The most conservative published critical loads for the most sensitive ecosite (bogs) is 5 kg ha^{-1} yr^{--1} (Bobbink and Roelofs 1995, WHO 2000). Therefore it is unlikely that baseline levels of nitrogen deposition will have an effect on vegetation or plant communities.

Similarly, PAI was not found to significantly effect soils (MEMS 2010a), and therefore no indirect effects on vegetation or plant communities is expected.

5.1.3 Vegetation Resources in the Project Area

Vegetation resources in the Project Footprint (PF) are summarized below by ecosite phase, as these are the primary landscape units used in this assessment.

b1 blueberry jack pine-aspen

- rare plant potential is low; four are plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of blueberry, bog cranberry, choke cherry, and pin cherry;
- occupies 32.4 ha of the PF, 0.2% of the LSA, and 3.0% of the total b1 area within the LSA

b2 blueberry aspen-paper birch

- rare plant potential is low; eight rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of blueberry, bog cranberry, choke cherry, and pin cherry;
- limited distribution within the LSA and RSA;
- not present in the PF

b3 blueberry aspen-white spruce

- rare plant potential is very low; this phase was not surveyed so no rare plants were observed;
- old growth potential is moderate;
- traditional plant potential is low; this phase supports communities of blueberry, bog cranberry, and choke cherry;
- limited distribution within the LSA and RSA;
- not present in the PF

b4 blueberry white spruce-jack pine

- rare plant potential is low; this phase was not surveyed so no rare plants were observed;
- old growth potential is low;
- traditional plant potential is low; this phase supports communities of blueberry, bog cranberry, and choke cherry;
- limited distribution within the LSA and RSA;
- not present in the PF

c1 jack pine-black spruce/Labrador tea – mesic

- rare plant potential is high; 12 rare plant species were observed;
- old growth potential is low;
- traditional plant potential is moderate; this phase supports communities of blueberry and bog cranberry;
- occupies 146.6 ha of the PF, 0.9% of the LSA, and 4.4% of the total c1 area within the LSA

d1 low-bush cranberry/aspen

- rare plant potential is very high; six rare plant species were observed;
- old growth potential is high;
- traditional plant potential is high; this phase supports communities of choke cherry, hazelnut, low-bush cranberry, pin cherry, saskatoon, raspberry and strawberry;

- limited distribution within the LSA but not limited within the RSA;
- occupies 0.6 ha of the PF, <0.1% of the LSA, and 0.8% of the total d1 area within the LSA

d2 low-bush cranberry/aspen-white spruce

- rare plant potential is very high; two rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is high; this phase supports communities of choke cherry, hazelnut, low-bush cranberry, pin cherry, saskatoon, raspberry and strawberry;
- limited distribution within the LSA but not limited within the RSA;
- occupies 2 ha of the PF, <0.1% of the LSA, and 2.2% of the total d2 area within the LSA

d3 low-bush cranberry/white spruce

- rare plant potential is high; two rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is high; this phase supports communities of choke cherry, low-bush cranberry and strawberry;
- limited distribution within the LSA and RSA;
- occupies 4.3 ha of the PF, <0.1% of the LSA, and 5.2% of the total d3 area within the LSA

e1 dogwood/balsam poplar-aspen

- rare plant potential is moderate; seven rare plant species were observed;
- old growth potential is high;
- traditional plant potential is high; this phase supports communities of currants and gooseberry, low-bush cranberry, saskatoon, raspberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

e2 dogwood/balsam poplar-white spruce

- rare plant potential is low; two rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is high; this phase supports communities of currants and gooseberry, low-bush cranberry, raspberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

e3 dogwood white spruce

- rare plant potential is low; this phase was not surveyed so no rare plants were observed;
- old growth potential is low;
- traditional plant potential is high; this phase supports communities of currants and gooseberry, raspberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

f1 horsetail/balsam poplar-aspen

- rare plant potential is moderate; two rare plant species were observed;
- old growth potential is high;
- traditional plant potential is moderate; this phase supports communities of currants and gooseberry, pincherry, raspberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

f2 horsetail/ balsam poplar-white spruce

- rare plant potential is moderate; one rare plant species was observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of currants and gooseberry, pincherry, raspberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

f3 horsetail/white spruce

- rare plant potential is low; two rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of currants and gooseberry and strawberry;
- limited distribution within the LSA and RSA;
- not present in the PF

g1 black spruce-jack pine/Labrador tea-subhygric

- rare plant potential is very high; eight rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of blueberry, bog cranberry, and currants and gooseberry;
- occupies 132.9 ha of the PF, 0.9% of the LSA, and 5.6% of the total g1 area within the LSA

h1 white spruce-black spruce/Labrador tea/horsetail

- rare plant potential is high; five rare plant species were observed;
- old growth potential is low;
- traditional plant potential is moderate; this phase supports communities of currants and gooseberry;
- limited distribution within the LSA and RSA;
- occupies 2.5 ha of the PF, <0.1% of the LSA, and 3.4% of the total h1 area within the LSA

i1 treed bog

- rare plant potential is very high; 14 rare plant species were observed;
- old growth potential is low;
- traditional plant potential is low; this phase supports communities of bog cranberry and cloudberry;
- occupies 50.3 ha of the PF, 0.3% of the LSA, and 5.0% of the total i1 area within the LSA

i2 shrubby bog

- rare plant potential is very high; nine rare plant species were observed;
- old growth potential is low;
- traditional plant potential is moderate; this phase supports communities of bog cranberry and cloudberry;
- occupies 78.0 ha of the PF, 0.5% of the LSA, and 2.5% of the total i2 area within the LSA

j1 treed poor fen

- rare plant potential is very high; 13 rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase supports communities of bog cranberry and cloudberry;
- occupies 9.2 ha of the PF, <0.1% of the LSA, and 1.8% of the total j1 area within the LSA

j2 shrubby poor fen

- rare plant potential is high; eight rare plant species were observed;
- old growth potential is low;
- traditional plant potential is moderate; this phase supports communities of bog cranberry and cloudberry;
- occupies 27.4 ha of the PF, 0.2% of the LSA, and 2.1% of the total j2 area within the LSA

k1 treed rich fen

- rare plant potential is very high; nine rare plant species were observed;
- old growth potential is moderate;
- traditional plant potential is moderate; this phase does not support any of the traditionally used berry communities;
- occupies 2.9 ha of the PF, <0.1% of the LSA, and 0.7% of the total k1 area within the LSA

k2 shrubby rich fen

- rare plant potential is very high; 14 rare plant species were observed;
- old growth potential is low;
- traditional plant potential is moderate; this phase does not support any of the traditionally used berry communities;
- occupies 19.4 ha of the PF, 0.1% of the LSA, and 2.0% of the total k2 area within the LSA

k3 graminoid rich fen

- rare plant potential is moderate; six rare plant species were observed;
- ecosite phase is not forested and therefore no old growth potential;
- traditional plant potential is moderate; this phase does not support any of the traditionally used berry communities;
- occupies 2.8 ha of the PF, <0.1% of the LSA, and 1.3% of the total k3 area within the LSA

l1 marsh

- rare plant potential is very low; three rare plant species were observed;
- ecosite phase is not forested and therefore no old growth potential;
- traditional plant potential is moderate; this phase does not support any of the traditionally used berry communities;
- limited distribution within the LSA and RSA;
- occupies 0.1 ha of the PF, <0.1% of the LSA, and 1.6% of the total l1 area within the LSA

5.2 Wetlands

5.2.1 Local Study Area

5.2.1.1 Distribution of Wetland Types in the LSA

Table 5-9 shows the extent of each AWIS wetland type in the PF, LSA and RSA. The distribution of wetlands in the RSA is further discussed in Section 5.2.2.

Table 5-9: Wetland distribution in the PF, LSA and RSA

Alberta Wetland Code	Total area in PF (ha)[1]	Percent of PF (%)	Total area in LSA (ha)	Percent of LSA (%)	Total area in RSA (ha)	Percent cover in RSA (%)
BTNI	0.0	0.0	0.0	0.0	158.4	0.3
BTNN	128.3	24.6	4,092.8	26.6	15,391.7	26.8
FONG	2.8	0.5	210.5	1.4	1,426.0	2.5
FONS	20.3	3.9	928.0	6.0	3,914.8	6.8
FOPN	0.0	0.0	0.0	0.0	5.5	<0.1
FTNI	0.0	0.0	0.0	0.0	109.1	0.2
FTNN	38.5	7.4	2,234.2	14.5	12,278.0	21.4
MONG	0.1	<0.0	6.0	<0.1	18.2	<0.1
SFNN	0.1	<0.0	91.9	0.6	112.0	0.2
SONS	0.0	0.0	0.0	0.0	225.7	0.4
STNN	0.0	0.0	16.0	0.1	29.2	0.1
Flooded	0.0	0.0	4.9	<0.1	12.6	<0.1
Ponds and Lakes	0.0	0.0	75.4	0.5	226.7	0.4
Wetland subtotal	**190.1**	**36.5**	**7,659.6**	**49.8**	**33,907.9**	**59.0**
Non-wetland subtotal	330.7	63.5	7,711.8	50.2	23,550.5	41.0
Total	**520.8**	**100.0**	**15,371.4**	**100.0**	**57,458.4**	**100.0**

[1] – Total area in PF is a summary of all three Project phases together.

Wetlands constitute 49.8% of the LSA. For mapping purposes, it was necessary to map wetland complexes (areas containing more than one wetland type) found in each polygon separately. Dominant wetland types are those with the highest coverage within the polygon. For example, in a treed fen there are often scattered pockets of open, graminoid fen. In this case, the dominant wetland type would be FTNN, and the secondary type would be FONG. Figure 5-5 shows the location of dominant wetland types within the LSA. Secondary wetland types are not continuous within mapped polygons, but are a minor component, frequently found in scattered or isolated pockets.

Wooded bogs are the most dominant wetland type in the LSA (BTNN 26.6%), followed by rich wooded fens (FTNN 14.5%). Wetlands of limited distribution in the LSA are marshes (MONG <0.1%), wooded swamps (STNN 0.1%), and forested swamps (SFNN 0.6%). Flooded areas (NWF) and ponds and lakes (NWL) are also limited in distribution in the LSA.

A description of the wetland types found in the LSA is presented in Appendix 6.

5.2.2 Regional Study Area

Wetland types found in the RSA are summarized in Table 5-9. Wetlands occupy 59% of the RSA (Figure 5-5). Wooded bogs were the most common wetland type (26.8%), followed by wooded fen (21.4%). Seven wetlands are limited in distribution within the RSA (<1%). In addition to the wetlands of limited distribution in the LSA, wooded bogs (BTNI 0.3%), patterned open fen (FOPN <0.1%), wooded fen with internal lawns (FTNI 0.2%), and deciduous swamps (SONS 0.4%) also occupy less than 1% of the RSA. These additional wetland types are also described in Appendix 6.

5.2.3 Wetland Resources in the Project Area

Wooded bogs without internal lawns (BTNN)

- occupies 128.3 ha of the PF, 0.8% of the LSA, and 3.1% of the total BTNN area within the LSA.

Non-patterned, open, graminoid-dominated fens (FONG)

- occupies 2.8 ha of the PF, <0.1% of the LSA, and 1.3% of the total FONG area within the LSA.

Non-patterned, open, shrub-dominated fens (FONS)

- occupies 20.3 ha of the PF, 0.1% of the LSA, and 2.2% of the total FONS area within the LSA.

Non-patterned wooded fens with no internal lawns (FTNN)

- occupies 38.5 ha of the PF, 0.3% of the LSA, and 1.7% of the total FTNN area within the LSA.

Marshes (MONG)

- limited distribution within the LSA and RSA;
- occupies 38.5 ha of the PF, <0.1% of the LSA, and 1.7% of the total MONG area within the LSA.

Swamps (SFNN)

- limited distribution within the LSA and RSA;
- occupies 0.1 ha of the PF, <0.1% of the LSA, and 0.1% of the total SFNN area within the LSA.

5.3 Rare Plants

5.3.1 ANHIC Database Query

ANHIC was contacted and a query of townships within the entire RSA was requested (Appendix 7). Five rare bryophyte species and one rare vascular species were reported present within the RSA, and all within the Pod One study area (Section 3.3.3, Appendix 7).

5.3.2 Rare Plants

Forty-three plants found on the Alberta Rare Plant Tracking and Watch Lists (Kemper 2009) were found within the LSA (Figure 5-6). Of these, six were vascular plants (with 15 occurrences), 18 were bryophytes (with 35 occurrences), and 19 were lichens (with 102 occurrences). Also, 16 lichen species that do not appear on the ANHIC All Lichen Elements List were observed in the LSA (with 23 occurrences). A summary of the species found, the habitat(s) in which they were found, their provincial and global, and their status in adjacent regions, is given in Table 5-10. The ASRD status has also been reported for each species (when available), and plant community types follow Beckingham and Archibald (1996). A complete list of all rare plants found including their UTM coordinate locations is included in Appendix 8.

Drosera linearis (slender-leaved sundew) was observed in the LSA and is on the Alberta Plant Watch List (Kemper 2009). This species is not tracked. Tracked species are those elements of the Alberta flora that are either rare or of conservation concern for some other reason, while watched species are not an immediate conservation concern, but are priority taxa for which further information is required (Kemper 2009). In order to provide data on this species to ANHIC, *D. linearis* is recorded on the rare plant figure. However, only tracked species are considered rare plants in this assessment.

Table 5-10: Rare plant occurrences in the LSA

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2005 Status
		In PF	Outside PF		B.C.	Sask.		
Vascular Plants								
Carex scoparia - pointed broom sedge	l1.2	0	1	S1	S2S3	SNR	G5	May be at Risk
Carex vesicaria - blister sedge	k2.1	0	1	S1	S4	SNR	G5	Undetermined
Chrysosplenium iowense – golden saxifrage	e2.3, e1.3, j1.1, k1.1, k2.2, k2.2, k2.3 k3.1,l1.2	2[1]	8	S3?	S2S3	S1?	G3?	Sensitive
Drosera linearis - slender-leaved sundew	i2.1	0	1	S3[2]	S1	S1	G4	Sensitive
Juncus stygius var americanus - marsh rush	i2.1	0	1	S2	S1S2	S1?	G5T5	No status[3]
Potamogeton foliosus - leafy pondweed	j1.1	0	1	S2	S4	SNR	G5	Secure
Bryophytes								
Cephalozia bicuspidata-two-horned pincerwort	k3.1	0	1	S1	-	-	G5	No status[4]
Cephaloziella hampeana-Hampe's threadwort	k3.2, c1.1	1	1	S1	-	-	G5	No status
Chiloscyphus pallescens - pale liverwort	i2.1	0	1	S1	-	-	G5	No status
Conocephalum conicum - snake liverwort	e2.3, e1.3	0	2	S2	-	-	G5	No status
Hygroamblystegium tenax (moss)	e1.3	0	1	S2	S2S3	SNR	G5	No status
Leskeella nervosa (moss)	d1.5, e1.2	0	2	S2	S3S4	SNR	G5	No status

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2005 Status
		In PF	Outside PF		B.C.	Sask.		
Lophozia excisa - capitate notchwort	f1.1, i1.1, j1.1, j2.1, k1.1,	1[1]	5	S1	-	-	G5	No status
Lophozia heterocolpos (liverwort)	k2.1	0	1	S2	-	-	G5	No status
Lophozia incisa – jagged notchwort	i2.1	0	1	S2	-	-	G5	No status
Orthotrichum affine - wood bristle moss	b2.3, k2.2	1[1]	1	SU	S2S3		G3G5	No status
Pseudobryum cinclidioides (moss)	k1.1, i1.1	2	0	S2	S1S3	SNR	G5	No status
Riccardia multifida - delicate germanderwort	i1.1	0	1	S2S3	-	-	G5	No status
Sarmenthypnum sarmentosum - twiggy spear-moss	k2.1	0	1	S2	S3S5	-	G4G5	No status
Scapania cuspiduligera – untidy earwort	j1.1	0	1	S2	SNR	-	G5	No status
Splachnum ampullaceum – flagon-fruited splachnum	i1.1, j2.1, k3.1	0	3	S2	S3S5	SNR	G5	No status
Splachnum luteum – yellow collar moss	f3.1, j2.1, k3.1	1	3	S3	S2S3	S3?	G3	No status
Splachnum rubrum – red collar moss	c1.1, h1.1, k3.1,	0	3	S3	S1S3	S3?	G3	No status
Splachnum vasculosum – rugged collar moss	b2.3	0	1	S2	S1S3	-	G3G5	No status
Lichens								
Arthonia patellulata – aspen comma	c1.2, d1.4, d2.4, k2.3	1	4	S3?	-	-	G5	No status
Biatora albohyalina	i1.1	1	0	[5]	-	-	GNR	No status

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2005 Status
		In PF	Outside PF		B.C.	Sask.		
Biatora chrysantha	d3.4	0	1	[5]	-	-	GNR	No status
Biatora efflorescens	d1.8	0	1	[5]	-	-	GNR	No status
Biatora pallens	d1.8	0	1	[5]	-	-	G3G5	No status
Biatora pullata	j1.1	0	1	[5]	-	-	GNR	No status
Bryoria simplicior – simple horsehair	b2.3, c1.1, d3.4, f1.1, f3.1, g1.1, i1.1, l1.3, j1.1, j2.1, j2.2, k1.1, k2.1, k2.3	3[1]	14	S2S3	SNR	S3	G3G5	No status
Cladina stygia - black-footed reindeer lichen	c1.1, g1.1, g1.2, i1.1, i2.1, , j1.1	6[1]	12	S1	-	SNR	G5	No status
Cladonia albonigra – sordid pixie-cup	j1.1, i1.1	0	2	[5]	-	-	GNR	No status
Cladonia bacilliformis - yellow tiny toothpick cladonia	b2.3, i2.1, j1.1, j2.1	0	4	S2S3	SNR	SNR	G4G5	No status
Cladonia cyanipes – greater greenhorn	g1.1, i1.1, j2.1, l2.1	1[1]	3	S2	SNR	S1S2	GNR	No status
Cladonia grayi - Gray's pixie-cup	c1.1, g1.1, k1.1	1[1]	5	S2	SNR	SNR	GU	No status
Cladonia merochlorophaea - gritty pixie-cup	b2.3, d2.3, h1.1, i1.1, j2.1, j2.2, j1.1	0	9	S2	SNR	-	GU	No status
Cladonia norvegica – least powderhorn	b1.3, k1.1	0	2	S1	SNR	-	G4G5	No status
Cladonia rei	i2.1	1	0	S2	SNR	S5	G3G5	No status
Cladonia umbricola - shaded cladonia	g1.1	0	1	S1	SNR	-	G3G5	No status
Lecanora albella	e1.3. k2.3	0	2	[5]	-	-	GNR	No status

Species	Plant Community Type	Occurrences		Alberta Rank	Adjacent Jurisdictions Rank		Global Rank	ASRD 2005 Status
		In PF	Outside PF		B.C.	Sask.		
Lecanora boligera	k2.1, k1.1	1[1]	2	[5]	-	-	GNR	No status
Lecanora densa	g1.1	1	0	[5]	-	-	GNR	No status
Lecanora hybocarpa – bumpy rim-lichen	j1.1	0	1	S1	-	-	G5	No status
Lecidea leprarioides	i1.1, b2.3, k1.1	2[1]	2	[5]	-	-	GNR	No status
Micarea denigrata	k2.1, c1.1	0	2	SNR	-	-	G2G4	No status
Micarea misella	k2.2	0	1	[5]	-	-	GNR	No status
Mycobilimbia hypnorum	d1.5, h1.1	0	2	S1	-	-	GNR	No status
Nephroma bellum - naked kidney lichen	b1.3, e1.2	0	2	S2	SNR	S3S5	G3G5	No status
Omphalina umbellifera - greenpea mushroom lichen	g1.1, h1.1, i1.1, i2.1, j1.1, j2.1, k2.2, k2.2, k2.3,	2[1]	10	S1	-	S1	GNR	No status
Peltiigera conspersa	c1.1	0	1	[5]	-	-	SNR	No status
Pycnora leucococca	i1.1	0	1	[5]	-	-	G3?	No status
Placynthiella uliginosa	c1.1	0	1	S2	-	-	G5	No status
Pseudevernia consocians – common antler lichen	i1.1	0	1	S1	-	-	G3G5	No status
Ramalina dilacerata - punctured gristle	b2.3, d1.5, e1.2, e1.3, g1.1, h1.1, i1.1, j1.1, k2.1, k2.3	1	9	S2	SNR	S3	G3G5	No status
Rinodina orculata	f2.1	0	1	[5]	-	-		No status
Trapeliopsis viridescens	c1.1	0	1	[5]	-	-	G4G5	No status
Xylographa parallela	b1.3, b2.3	1[1]	3	S2	-	S2	G5	No status
Xylographa trunciseda	k2.1	0	1	[5]	-	-	GNR	No status

[1] – Plot center is within 40 m of the PF. Although plot center does not fall within the PF, species is considered to fall within the PF due to the wandering nature of rare plant surveys.
[2] – *Drosera linearis* is found only on the Alberta Watch List and is not tracked in the province.
[3] – *Juncus stygius* var. *americanus* does not appear on the ASRD list of species at risk, however *Juncus stygius* was given an ASRD status of "May be At Risk" in 2005.
[4] – None of the bryophyte or lichen species have been given ASRD status.
[5] – Species has not yet been reported on Alberta All Lichen Element List.

5.3.2.1 Rare Vascular Plant Descriptions

Carex scoparia – pointed broom sedge

Carex scoparia is a densely caespitose sedge with 20-80 cm tall culms growing in moist open woodlands (Moss 1983). It has 3-10 ovoid to obovoid, straw-coloured spikes with perigyna that are ovate-lanceolate, straw-coloured to brown, galbrous, thin, and wing-margined to the base. *C. scoparia* is ranked S1 (critically imperilled) in Alberta, S2S3 (likely vulnerable) in BC, and SNR (not ranked) in Saskatchewan (Natureserve 2009, ANHIC 2010). Its ASRD status is "May be at Risk" (ASRD 2005). Globally, it is ranked G5 (abundant, widespread, and secure). *C. scoparia* was observed once in a cattail marsh (I1).

Carex vesicaria – blister sedge

Carex vesicaria is a 30-100 cm tall, tufted and rhizomatous sedge with culms that are often reddish at the base (Kershaw *et al*. 2001). Typically, it grows in swamps, shorelines, and marshes. Its leaves are rough and inrolled and have distinctive knobby cross-partitions. The flower clusters are elongated and contain 3-7 erect, sessile spikes of which the upper 2-4 have only male flowers, and the lower only female. The lowermost bract is leaf-like and generally exceeds the flower cluster. Perigynia are yellowish to brown and 4-8 mm long, with 7-20 ribs and a smooth, slender beak with two spreading teeth. *C. vesicaria* is ranked S1 (critically imperilled) in Alberta, SNR (not ranked) in Saskatchewan, and S4 (apparently secure) in BC (Natureserve 2009). The other Alberta records for this species are along the far southwestern border, so this record represents a significant range extension for this species. It has an ASRD status of "Undetermined" (ASRD 2005) and globally it is ranked G5 (secure). It was found in a flat-leaved willow (*Salix planifolia*) dominated shrubby rich fen (k2).

Chrysosplenium iowense – golden saxifrage

Chrysosplenium iowense is a small perennial herb with a stoloniferous habit and golden-yellow sepals that have a wider outer pair. Flowers appear from May-July, and its leaves are conspicuously veined (Johnson *et al*. 1995). Golden saxifrage is found in moist, shady areas, often with rich soil, such as along streambanks and within wetlands (Johnson *et al*. 1995, Moss 1983). In the United States, it may also grow on north-facing talus slopes above streams, with occurrences often near cold groundwater seeps or ice caves (Roosa and Eilers 1978). Population sizes are not big, with a couple hundred individuals at most (NatureServe 2009). This may be because this species does not develop flowering stems until the second season (Rosendahl 1947); flowering is temperature dependent, maximum production occurring at 11-12 degrees Celsius (Smith 1981); plants are not self-compatible, requiring insect pollination (Weber 1979). Also dispersal of seeds is done via drops of rain falling into the cup-shaped capsules containing the seeds, essentially splashing them out, but they rarely travel more than 15 cm from the cup (Johnson *et al*. 1995). *C. iowense* is primarily a Canadian species, occurring from the Northwest Territories south into British Columbia, Alberta, Saskatchewan, and Manitoba (NatureServe 2009). Golden saxifrage is ranked S3? (most likely vulnerable) in Alberta, S2S3 (imperilled but likely vulnerable) in BC, and S1? (most likely critically imperilled) in Saskatchewan (NatureServe 2009). Its ASRD status is "Sensitive" (ASRD 2005). Globally, it is ranked as G3? (most likely vulnerable), suggesting it may be locally abundant in some areas and rare in others, and its range may be restricted (Natureserve 2009). *C. iowense* occurred 10 times in a variety of ecosite phases (Table 5-10).

***Drosera linearis* – slender-leaved sundew**

Drosera linearis is a sundew, which are insectivorous plants that capture insects with sticky hairs. These reddish sticky hairs are located on the leaves, which, in *D. linearis*, are long and thin and roll up once an insect has been captured (Moss 1983). Its leaves are 2-5 cm long and about 2 mm wide. *D. linearis* has 1-4 flowers per flower stalk. It is ranked S3 (vulnerable) in Alberta and S1 (critically imperilled) in BC and Saskatchewan (Natureserve 2009, Kemper 2009). Its ASRD status is "Sensitive" and globally, it is ranked G4 (apparently secure). *D. linearis* is currently on the Alberta watch list (Kemper 2009). A single but large population of *D. linearis* was found together with the rare *Juncus stygius* var. *americanus* in a shrubby bog (i2).

***Juncus stygius* var. *americanus* – marsh rush**

Juncus stygius var*. americanus* is a short, 6-35 cm tall rush that grows singly or in small tufts from a creeping rhizome (Moss 1983). The leaves are very thin (less than 1 mm wide) and both basal and cauline leaves are present. Its inflorescence is terminal with a bract as long or slightly longer than the inflorescence. There is usually a single flower head with 1-4 flowers; when mature, the capsule is exserted. *J. stygius* var. *americanus* grows in bog pools. It is ranked S2 (imperilled) in Alberta, S2S3 (imperilled but likely vulnerable) in BC, and S1S2 (critically imperilled to imperilled) in Saskatchewan (Natureserve 2009, ANHIC 2010). *J. stygius* var*. americanus* does not have an ASRD status, however *J. stygius* has a status of "May be at Risk" (ASRRD 2005). Globally, it is ranked G5T5 (secure). This species was found once in a wet, shrubby bog (i2).

***Potamogeton foliosus* – leafy pondweed**

Potamogeton foliosus is a slender pondweed that grows entirely submerged in the water (Moss 1983). The leaves are long and thin (2-8 cm long x 1-3 mm wide) and 3-5 nerved. The nodes lack glands and the stipules disappear quickly and are not fibrous. *P. foliosus* is ranked S2 (imperilled) in Alberta, S4 (apparently secure) in BC, and SNR (not ranked) in Saskatchewan (Natureserve 2009, Kemper 2009). Its ASRD status is "Secure" (ASRD 2005), and globally it is ranked G5 (secure) (Natureserve 2009). *P. foliosus* occurred once in a water body associated with a treed poor fen (j1).

5.3.2.2 Rare Bryophyte Descriptions

Cephalozia bicuspidata – two-horned pincerwort

Cephalozia bicuspidata is a small, monoicous leafy liverwort less than 0.5 mm wide, and is a member of the Cephaloziaceae (Conard 1956). Its stems are covered in a layer of large transparent cells, and its leaves are obliquely attached to the stem, but not decurrent. They are also divided into two long, slender, parallel lobes to half the length of the leaf or more, and have cells that are 0.035-0.05 mm in diameter. It often has small-leaved branches termed “flagella”, and grows on conifers and coarse woody debris (Paton 1999). *C. bicuspidata* is ranked S1 (critically imperilled) in Alberta; and its global rank is G5 (secure) (Natureserve 2009). This species was found once in a rich graminoid fen (k3) dominated by sedges and peat mosses.

Cephaloziella hampeana **- Hampe’s threadwort**

Cephaloziella hampeana is a tiny member of the Cephaloziellaceae that is less than 0.5 mm wide and only 1-8 mm long (Weber and Wittmann 2003). The plants are greenish-brown and have bilobed leaves that are distant, strongly spreading, ovate-triangular, and 5-8 cells wide at the base. The lobes are acute and its cells are thin-walled. *C. hampeana* is not a calciphile and grows in wet places, often hidden among other bryophytes. In North America, it is known from Alberta to Quebec and south from Colorado and North Carolina (Natureserve 2009). This species is listed as S1 (critically imperilled) in Alberta and is globally secure with a rank of G5. *C. hampeana* was found twice in the survey, once each in a graminoid rich fen (k3) and in a Labrador tea-mesic jack pine-black spruce ecosite phase (c1).

Chiloscyphus pallescens **– pale liverwort**

Chiloscyphus pallescens is a small 1-6 cm long leafy liverwort with leaves to about 2 mm long and one to one-and-a-half times as long as wide (Paton 1999). It forms yellowish to pale or bright green mats on soil, decaying wood, and leaf litter. The leaves are imbricate to distant along the stem and are unlobed to very shallowly lobed with the apex slightly narrowed to truncate. The underleaves are small and are separated into two long, thin lobes for about half of their length, with margins that often bear sparse cilia-like teeth that may become lobe-like. The trilobed perianth lobes are strongly dentate to again lobed. *C. pallescens* is ranked S1 (critically imperilled) in Alberta and G5 (secure) globally. *C. pallescens* was found once in the survey, among lichens in a shrubby bog (i2).

Conocephalum conicum **– snake liverwort**

Conocephalum conicum is a shiny, thalloid (i.e. non-leafy) liverwort that resembles the more common *Marchantia polymorpha*, but never has gemmae cups, lacks marginal scales on the thallus undersides, has large, angular-patterned cells, and has an aromatic odour when crushed (Paton 1999, Schuster 1953. *C. conicum* forms yellowish-green to grey-green mats with lobes that are 4-17 mm wide and plants that are to 12 cm long or more. It occurs in moist habitats on soil, rocks, peat, and wood. *C. conicum* is ranked S2 (imperilled) in Alberta and G5 (abundant, widespread, and secure) (Natureserve 2009, Kemper 2009). This species was found at two sites in dogwood balsam poplar-aspen (e1) and dogwood balsam poplar-white spruce (e2) ecosite phases.

Hygroamblystegium tenax **– hygroamblystegium moss**

Hygroamblystegium tenax is a small, dark- to yellow-green pleurocapous moss growing in or near water on rock or roots (Crum and Anderson 1981, Smith 2006). Plants are slender with wiry stems that are irregularly pinnately branched. The leaves are 1-1.5 mm long and ovate to ovate-lanceolate and acuminate with a strong, yellowish midrib. *H. tenax* is ranked S2 (imperilled) in Alberta, S2S3 (likely vulnerable) in BC, and SNR (not ranked) in Saskatchewan (Natureserve 2009). Globally it is ranked G5 (secure). *H. tenax* was observed once in a dogwood balsam poplar-aspen (e1) ecosite phase.

Leskeella nervosa **- leskeella**

Leskeela nervosa is a slender, creeping, dark green to brownish pleurocarpous moss growing in dry to moist habitats on wood, bark, or rock (Crum and Anderson 1981). It has 0.8-1 mm long leaves that are ovate-lanceolate and acuminate with margins that are entire to minutely serrulate. The costa is strong and reaches to the leaf tip. Brood bodies are almost always present and are produced in leaf axils. *L. nervosa* is ranked S2 (imperilled) in Alberta, and S3S4 (likely secure) in BC, and SNR (not ranked) in Saskatchewan. Globally it is ranked G5 (secure). *L. nervosa* was found twice in the LSA; once each in dogwood balsam poplar-aspen (e1) and low-bush cranberry aspen (d1) ecosite phases.

Lophozia excisa **– capitate notchwort**

Lophozia excisa is a small leafy liverwort with plants mostly up to 1 cm long and 0.5-2.5 mm wide (Paton 1999). It forms dense to open, green to yellowish, reddish, purplish, or brownish mats, and grows among mosses, or often as a pioneer on moist gravel, peat, or soil. The leaves are shallowly two to occasionally 3-lobed, and the underleaves are absent or poorly developed. The plants are paroecious and have perianth bracts that are distinctly toothed (Schuster 1953). This species is ranked S1 (critically imperilled) in Alberta, (Natureserve 2009) and G5 (secure) globally. *L. excisa* was found six times among lichens in treed bogs (i1) and poor and rich fens, and once in a balsam poplar/aspen – horsetail (f1) ecosite phase.

Lophozia heterocolpos **- liverwort**

Lophozia heterocolpos is a small leafy liverwort with two-lobed leaves. Its shoots are 0.5-2 mm wide and form loose mats on or among mosses that are grey-green to brown, yellow, or even reddish (Paton 1999, Schuster 1953). The leaves are convex and obliquely inserted, and underleaves are present particularly near the apex of unmodified shoots. Unlike many similar species, it often has smooth, brownish gemmae present and is strongly aromatic. *L. heterocolpos* is ranked S2 (imperilled) in Alberta (Kemper 2009) and its global rank is G5 (secure) (Natureserve 2009). *L. heterocolpos* was found once in a shrubby rich fen (k2).

Lophozia incisa **– jagged notchwort**

Lophozia incisa is a small leafy liverwort forming dense to loose mats among mosses (particularly Sphagnum), and on peat and rotten wood, usually on acidic substrates (Paton 1999, Schuster 1953). The plants are mostly up to 1 cm long and 1-2 mm wide and are bluish-green to bright, pale or yellowish-green, with an opaque appearance. The leaves are mostly 2-4 lobed and have crispate and often strongly toothed margins, with the lobes generally being fairly shallow. *L. incisa* is ranked S2 (imperilled) in Alberta and G5 (secure) globally (Natureserve 2009). *L. incisa* was found once in a shrubby bog (i2).

Orthotrichum affine **– wood bristle moss**

Orthotrichum affine is a tufted, 1-3 cm long moss growing on trees. It has leaves that are somewhat pointed with a midrib that reaches or slightly exceeds the tips of the leaves (Crum and Anderson 1981, Lawton 1971). The stomata of the leaves are superficial and the leaf cells have 1-2 papillae (bumps) per cell. *O. affine* has a distinctive capsule that is strongly ribbed, shrunken under the mouth, with reflexed peristome teeth, and a short seta less than 1 mm long. This species is ranked SU (unrankable) in Alberta, S2S3 (imperilled but likely vulnerable) in BC (Natureserve 2009), and G3G5 (vulnerable but likely secure) globally. *O. affine* was observed twice in the survey in shrubby rich fen (k2) and blueberry aspen (b2) ecosite phases.

Pseudobryum cinclidioides

Pseudobryum cinclidioides is a robust green to greenish brown moss, and can be greater than 10 cm tall. It is characterized by large (up to 9 mm), elliptic leaves with rounded or bluntly apiculate apices. Three rows of elongated cells form an indistinct border. Margins are entire or with a few blunt teeth. Laminal cells are elongated, 3-4 times as long as wide, and arranged in diagonal rows. *P. cinclidioides* is found in wet areas; it is typically found in swampy soil or humus and occasionally on boulders or exposed tree roots. This species is found from Alaska to Greenland and south to Virginia, Michigan, Minnesota and Montana. It is also reported in swamps and mire in boreal Europe. *P. cinclidioides* was observed twice in the survey in a treed rich fen (k1) and a treed bog (i1).

Riccardia multifida **– delicate germanderwort**

Riccardia multifida is a thalloid (i.e. non-leafy) liverwort with thin (to 1.2 mm wide) lobes that often branch in a characteristic 2-3 times pinnate fashion (Paton 1999, Schuster 1953). The plants are up to 3 cm long and range in colour from grey-green to yellowish or reddish brown. It forms loose to dense mats most commonly in shaded microsites in bogs, fens, marshes, and other wet sites on peat, soil, rocks, and other materials. *R. multifida* is ranked S2S3 (imperilled but likely vulnerable) in Alberta and G5 (secure) globally (Natureserve 2009). This species was found once in a treed bog (i1).

Sarmenthypnum sarmentosum **– twiggy spear-moss**

Formerly known as *Calliergon sarmentosum*, this pleurocarpous moss is found in the Amblystegiaceae and is usually coloured orange, red, purple, or blackish (Lawton 1971). It forms tufts or mats of unbranched to regularly-branched plants in wet habitats. *S. sarmentosum* has leaves that end in a short, abrupt point, a distinct midrib that goes about three-quarters the way up the leaf, and are 1.5- 3 x 0.5-1 mm. They also have alar cells that are abruptly enlarged and entire margins. This species is ranked S2 (imperilled) in Alberta, S3S5 (likely abundant, widespread, and secure) in BC, and its global rank is G4G5 (apparently secure but likely secure) (Natureserve 2009). *S. sarmentosum* was found once in a shrubby rich fen (k2) adjacent to a stream, with dwarf birch, willows and sedges.

***Scapania cuspiduligera* – untidy earwort**

Scapania cuspiduligera is a leafy liverwort that is primarily arctic-alpine and grows on wet, calcareous substrates in shaded locales (Paton 1999, Schuster 1953). The plants are prostrate to somewhat erect, mostly 4-8 mm long and 1-2.5 mm wide, and light green to yellowish or whitish, with older parts becoming blackish. Its leaves are unequally two-lobed, with the lobes spreading and rounded, often with a point or a small area of serration at the tips. *S cuspiduligera* is an arctic-alpine species, common throughout western North America, from British Columbia and Alberta southward at high altitudes to Colorado and California, and into New Mexico. S. *cuspidiligera* is ranked S2 (imperilled) in Alberta, SNR (not ranked) in British Columbia, and G5 (widespread, abundant, and secure) globally (Natureserve 2009). This species was observed once during the survey in a treed poor fen (j1).

***Splachnum ampullaceum* – flagon-fruited collar moss**

Splachnum ampullaceum is a member of the Splachnaceae, characterized by relatively large leaves, urn- to umbrella-shaped capsules, and growth on dung and other animal-based organic matter (Crum and Anderson 1981, Lawton 1971). *S. ampulaceum* has oblanceolate leaves that become deeply serrate starting about halfway up the leaves. The capsule is pinkish becoming dark purple to red when dry and urn-shaped, with the lower part (apophysis) being top-shaped. *S. ampullaceum* is ranked S2 (imperilled) in Alberta, SNR (not ranked) in Saskatchewan, and S3S5 (likely abundant, widespread, and secure) in BC. Its global rank is G5 (secure). *S. ampullaceum* was found three times: once each in a treed bog (i1), a rich graminoid fen (k1), and a poor shrubby fen (j2).

***Splachnum luteum* – yellow collar moss**

Splachnum luteum is a unique moss with serrated leaves and sporophytes shaped like small yellow umbrellas (Johnson *et al*. 1995). The umbrellas are composed of thick, spongy tissue that give off a sour odor to attract flies, which in turn land on the umbrella, pick up the sticky spores, and distribute them to the next patch of moss (Johnson *et al*. 1995, Vitt *et al*. 1988). Yellow collar moss grows on moose (and occasionally, other herbivores') dung, which is why it has adapted to using flies to disperse its spores (Johnson *et al*. 1995). It is scattered across North America, occurring from Alaska to New Brunswick, and south into British Columbia, Alberta, and Saskatchewan (NatureServe 2009). It also occurs in northern Europe and Asia (NatureServe 2009). *S. lutuem* is given the ranking of S3 (vulnerable) in Alberta. It is ranked S2S3 (imperilled but likely vulnerable) in BC, S3? (probably vulnerable) in Saskatchewan, and G3 (vulnerable) globally (Kemper 2009). This species was found four times during the survey: once each in horsetail white spruce (f3), shrubby poor fen (j2) and graminoid rich fen (k3) ecosite phases.

***Splachnum rubrum* – red collar moss**

Splachnum rubrum is a moss with sporophytes shaped like small red umbrellas; the capsules are from 0.5 cm to over 1 cm across, and are suspended on pink setae from 2-15 cm high (Johnson *et al* 1995, Vitt *et al*. 1988). The sporophytes give off an odour that attracts passing flies, which land on the umbrellas and pick up spores to disperse to other Splachnum patches (Johnson *et al*. 1995). *S. rubrum* grows on moose, and occasionally other herbivores', dung, which is why its range follows closely that of the moose (Johnson *et al*. 1995, NatureServe 2009). This species is ranked S3 (vulnerable) in Alberta, S1S3 (critically imperilled but likely vulnerable) in BC, and S3? (probably vulnerable) in Saskatchewan (Kemper 2009, NatureServe 2009). Globally, it is ranked G3 (vulnerable). *S. rubrum* was observed three times in the survey; once each in Labrador tea-mesic jack pine-black spruce (c1), Labrador tea/horsetail white spruce-black spruce (h1), and graminoid rich fen (k3) ecosite phases.

***Splachnum vasculosum* – rugged collar moss**

Splachnum vasculosum is a member of the Splachnaceae, a family characterized by relatively large leaves, urn- to umbrella-shaped capsules, and growth on dung and other animal-based organic matter (Crum and Anderson 1981, Lawton 1971). *S. vasculosum* has bluntly obtuse, entire leaves (Crum and Anderson 1981). Its capsule is dark purple and the bottom part (apophysis) is almost globose. *S. vasculosum* is ranked S2 (imperilled) in Alberta, S1S3 (critically imperilled but likely vulnerable) in BC, and G3G5 (vulnerable but likely secure) globally (Natureserve 2009). *S. vasculosum* was found once in the survey, in a blueberry aspen (b2) ecosite phase.

5.3.2.3 Rare Lichen Descriptions

***Arthonia patellulata* - aspen comma**

Arthonia patellulata is a crust-forming lichen growing on aspen trunks (Brodo *et al*. 2001). It forms whitish, "dusty" patches with small, black, circular apothecia (fruiting bodies). Its spores are colourless, 2-celled, and strongly tapered. It is apparently common across the southern boreal forest and aspen parkland (Johnson *et al*. 1995), and is ranked S5 (abundant, widespread, and secure) in Saskatchewan and globally (Natureserve 2009). It is ranked S2 (imperilled) in Alberta, SNR in Saskatchewan, and G5 (abundant, widespread, and secure) globally. *A. patellulata* was found five times in the survey, once each in Labrador tea-mesic jack pine-black spruce (c1), low-bush cranberry aspen (d1), and low-bush cranberry aspen-white spruce (d2) ecosite phases, and twice in a shrubby rich fen (k2) ecosite phase.

***Biatora albohyalina* – dot lichen**

Biatora albohyalina, or more recently *Lecidea albohyalina*, is a crust lichen with a thin white thallus that is continuous or granular (Foucard 2001, Spribille 2006). The apothecia are convex, 0.1-0.3 mm in diameter, and yellow to reddish, and usually lack a margin. Spores are 9-11 x 2-3 μm. This species does not appear on ANHIC's All Lichen Element List (ANHIC 2010) and its global rank is GNR (not ranked). *B. albohyalina* was found once in the survey, in a treed bog (i1) ecosite phase.

Biatora chrysantha – dot lichen

Biatora chrysantha is a crust lichen forming patches up to 10 cm across that are light to medium creamy yellow-green and sorediate-granular, usually with a few corticate areoles (Foucard 2001, Spribille 2006). Apothecia are rare and pale yellowish tan, with a thin, receding rim, and lack distinctly pigmented layers in section. The asci are Biatora-type with eight spores per ascus that measure 12-15.5 x 3.5-6 µm. This species is found on mosses over logs, trunk bases and stumps, and occasionally on bark wood or rock. It is considered widespread and common in dry to moist conifer forests. This species does not appear on ANHIC's All Lichen Element List (ANHIC 2010) or in the Natureserve database (2009). However, it is on the current checklist for species occurring in North America (Esslinger 2008). *B. chrysantha* was recorded once in the survey in a low-bush cranberry white spruce (d3) ecosite phase.

Biatora efflorescens – dot lichen

Biatora efflorescens is a pale yellowish green crust lichen forming patches up to about 3 cm wide, with a thallus formed of dispersed, solitary areoles, sometimes on a gray hypothallus (Foucard 2001, Spribille 2006). The areoles quickly break down into soralia, which remain solitary or occasionally grow together. Apothecia are rare, have a thin, receding rim, and lack any distinctly pigmented layers in section. The asci are Biatora-type with eight spores per ascus, which measure 9-22 x 3-5 µm. It grows on the smooth, acidic bark of shrubs, especially those of the Ericaceae. This species does not appear on ANHIC's All Lichen Element List (ANHIC 2010), although it is listed on NatureServe (2009) with a global rank of GNR (not ranked), and it is on the North American lichen checklist (Esslinger 2008). *B. efflorescens* was found once in the survey, in a low-bush cranberry aspen (d1) ecosite phase.

Biatora pallens – dotted lichen

Biatora pallens (formerly *Bacidia pallen*) is a small crust lichen, usually covering less than 1 cm^2, growing on conifer and deciduous tree branches in cold boreal forests (Thomson 1997). It has an inconspicuous, granular and often areolate thallus that is pale to medium green or grey-green. Apothecia are pale and pinkish to yellowish, and have narrowly oblong to elliptic spores that are four-celled. Its recorded distribution from Scandanavia, Finland, and the Northwest Territories (Natureserve 2009). This species does not appear on ANHIC's All Lichen Element List (ANHIC 2010), although it has a global rank of G3G5 (currently vulnerable, but likely secure). In North America, distribution data are known to be incomplete for this species (NatureServe 2009). *B. pallens* was found once in the survey, in a low-bush cranberry aspen (d1) ecosite phase.

Biatora pullata – dot lichen

Biatora pullata, also known as *Lecidea pullata* or *L. amaurospoda*, is a crust lichen with a grey-brown to yellowish thallus that may be sorediate, granular, or areolate (Ozenda and Clauzade 1970). Areoles may be dispersed to contiguous and soredia are grey-brown to grey-green. Apothecia are often present and are 0.3-0.5 mm in diameter and black. This species does not appear on ANHIC's All Lichen Element List (ANHIC 2010), although it has a global rank of GNR (not ranked) and is known from France (Natureserve 2009, Ozenda and Clauzade 1970). *B. pullata* was found once in the survey, in a treed poor fen (j1).

Bryoria simplicior **– simple horsehair**

Bryoria simplicior is a dark, shrubby fruticose lichen growing on conifer branches and twigs in the boreal forest, often mixed in with the more common *Bryoria lanestris* (Johnson *et al*. 1995, Brodo *et al*. 2001). It is distinguished from other *Bryoria* species by its shrubby growth and its soralia, which do not change colour in *para*-phenylenediamine (Brodo *et al*. 2001). Most references consider it common (Johnson *et al*. 1995, Brodo *et al*. 2001). *B. simplicior* is ranked S2S3 (imperilled but likely vulnerable) in Alberta, SNR (not ranked) in BC, and S3 (vulnerable) in Saskatchewan (Kemper 2009). It is considered GNR (not ranked) globally (Natureserve 2009). *B. simplicior* was found in 17 plots in a variety of ecosite phases (Table 5-10).

Cladina stygia **– black-footed reindeer lichen**

Cladina stygia is a highly branched fruticose shrub lichen in the Cladoniaceae. It closely resembles the common *Cladina rangifera* (gray reindeer lichen) in being grayish in colour, having slightly side-swept branches, and in having pycnidia (small black fungal fruiting bodies immersed in the lichen) (Brodo *et al*. 2001). However, *C. stygia* is more sparsely branched, is dark brown to blackish near the base, and has pinkish (rather than clear) jelly in its pycnidia. *C. stygia* grows in open, wet to boggy sites (Brodo *et al*. 2001) and is known from Alaska south and east throughout Canada, the northeastern states, and New England (Brodo *et al*. 2001, Natureserve 2008). It is rated S1 (critically imperilled) in Alberta, SNR in Saskatchewan and BC, and G5 globally (Kemper 2009, Natureserve 2009). *C. stygia* was observed in 18 locations in the survey in a variety of ecosite phases (Table 5-10).

Cladonia albonigra **– cup lichen**

Cladonia albonigra is a member of the *Cladonia chlorophaea* group, which are characterized by greenish grey or brown, broadly goblet-shaped podetia covered in granular soredia. *C. albonigra* is distinguished by having a stalk that darkens towards the base and cups that often proliferate from both the margins and the centres of the cups below (Brodo *et al*. 2001, Goward 1999). As well, it usually contains fumarprotocetraric acid. It grows on soil, moss, and wood in open forested areas (Goward 1999). All Lichen Element List (ANHIC 2010), nor is it listed on Natureserve (Kemper 2009, Natureserve 2009). However, in British Columbia it is considered frequent (Goward 1999). This species was found twice, once each in a treed bog (i1) and a treed poor fen (j1).

Cladonia bacilliformis **– yellow tiny toothpick cladonia**

Cladonia bacilliformis is a small, yellowish lichen with unbranched, pointed podetia covered in powdery soredia (Goward 1999). It grows most frequently on decaying wood in open, inland locations at lower elevations. *C. bacilliformis* is ranked G4G5 (likely secure) globally, but is S2S3 (likely vulnerable) in Alberta, SNR (not ranked) in Saskatchewan and BC (Natureserve 2009). This species was found four times in the survey, once in a blueberry aspen (b2) ecosite phase, once in a shrubby bog (i2), and twice in poor shrubby fens (j2).

***Cladonia cyanipes* – greater greenhorn**

Cladonia cyanipes forms tall (2-6 cm) unbranched to sparingly branched, pointed podetia that are yellowish-green and covered in powdery soredia (Goward 1999, Hale 1979). The bases of the podetia are often bluish. *C. cyanipes* typically grows on moss and humus over rocks. This species is ranked S2 (imperilled) in Alberta, SNR (not ranked) in BC, S1S2 in Saskatchewan and GNR (not ranked) globally (Natureserve 2009). *C. cyanipes* was found four times during the survey: in shrubby poor fen (j2), Labrador tea-subhygric black spruce-jack pine (g1), shrubby bog (i2), and treed bog (i1) ecosite phases.

***Cladonia grayi* – Gray's pixie-cup**

Cladonia grayi is a member of the *Cladonia chlorophaea* group, which are characterized by greenish grey or brown, broadly goblet-shaped podetia covered in granular soredia. *Cladonia grayi* is distinguished by containing grayanic acid and not blackening towards the base (Goward 1999). It grows on acidic soil, conifer wood, and tree bases at inland locales. *C. grayi* is ranked S2 (imperilled) in Alberta, SNR (not ranked) in BC and Saskatchewan, and GU (unrankable) globally (Natureserve 2009). *C. grayi* was found six times during the survey, in blueberry jack pine-aspen (b1), Labrador tea-mesic jack pine-black spruce (c1), Labrador tea-subhygric black spruce-jack pine (g1), and twice in treed rich fen (k1) ecosite phases.

***Cladonia merochlorophaea* – gritty pixie-cup**

Cladonia merochlorophaea is a member of the *Cladonia chlorophaea* group, which are characterized by greenish grey or brown, broadly goblet-shaped podetia covered in granular soredia. *C. merochlorophaea* contains merochlorophaeic and 4-0-methylcryptochlorophaeic acids, and is not blackened towards the base (Goward 1999). This is detected by a brief pinkish-purple reaction after placing potassium hydroxide and then calcium hypochlorite on the specimen. It grows over moss and mossy rock in open to somewhat sheltered areas. *C. merochlorophaea* is ranked S2 (imperilled) in Alberta, SNR (not ranked) in BC and GU (unrankable) globally (Natureserve 2009). *C. merochlorophaea* was observed in nine sites in a variety of ecosites (Table 5-10).

***Cladonia norvegica* – least powderhorn**

Cladonia norvegica is a fruticose lichen with small, unbranched, pointed podetia that are covered in powdery soredia (Goward 1999). It is differentiated from similar species by having tiny basal squamules, the lack of colour change with potassium hydroxide and *para*-phenylenediamine, and its habitat on bark and wood. *C. norvegica* is ranked S1 (critically imperilled) in Alberta, SNR (not ranked) in BC and G4G5 (likely abundant, widespread, and secure) globally (Natureserve 2009). *C. norvegica* was found twice in the survey: once each in blueberry jack pine-aspen (b1) and treed rich fen (k1) ecosite phases.

Cladonia rei – wand lichen

Cladonia rei is a greenish, often patchily-browned fruticose lichen that forms tall sorediate podetia that are usually narrowly cupped (Brodo *et al*. 2001). These cups are often lopsided and proliferate at the margins to resemble a star, the proliferations being short and often tipped with brown apothecia. It grows in open sites on soil or wood, and may act as a pioneer species. *C. rei* is ranked S2 (imperilled) in Alberta, SNR (not ranked) in BC, and S5 (secure) in Saskatchewan (Natureserve 2009). Its global rank is G3G5 (vulnerable but likely secure). *C. rei* was observed once in the survey in a shrubby bog (i1).

Cladonia umbricola **– shaded cladonia**

Cladonia umbricola is a variable fruticose lichen that has unbranched, finely sorediate podetia that either form small cups or taper to a blunt tip (Goward 1999, Brodo *et al*. 2001). Its colour ranges from yellowish to greyish green. Its basal squamules are medium sized, deeply lobed, and often turn orange towards the bases of the podetia. *C. umbricola* grows strictly over wood or bark, generally in shady old-growth forests, at middle to lower elevations (Goward 1999). It is ranked S1 (critically imperilled) in Alberta, SNR in BC, and G3G5 (vulnerable but likely secure) globally (Natureserve 2009). This species was found once in a Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase.

Lecanora albella **– rim lichen**

Lecanora albella is a whitish crust lichen growing on conifers (Brodo *et al*. 2001). It has small (less than 1.5 mm diameter), whitish apothecia that are strongly pruinose, have oxalate crystals in the amphithecium, and turn yellow in potassium hydroxide and reddish in *para*-phenylenediamine. The apothecia have narrow margins. This species does not appear on ANHIC's Tracking and Watch List (Kemper 2009), and globally its status is GNR (not ranked) (Natureserve 2009). *L. albella* was found twice in the survey, once each in dogwood balsam-poplar-aspen (e1) and shrubby rich fen (k2) ecosite phases.

Lecanora boligera **– rim lichen**

Lecanora boligera is a crust lichen growing on the dead twigs of dwarf shrubs (Daniëls et. al 1985). It has little to no visible thallus, typically creating inconspicuous plants with only a few apothecia. Apothecia are pale and have asci with thick tholi, with spores that are spherical and 6-7 µm in diameter. *L. boligera* does not appear on ANHIC's Tracking and Watch List (Kemper 2009), and its global status is GNR (not ranked) (Natureserve 2009). This species was found three times in the survey in shrubby rich fens (k2), and in a treed rich fen (k1).

Lecanora densa

Lecanora densa is an areolate lichen known from collections of twigs of *Acer grandidentata*, *Picea* sp. *Pinus* spp., *Pseudotseuga menziesii*, and *Quercus* spp. The areoles are isodiametric, occasionally with a crenulate or incised margin, and average 0.15- 0.25 mm in diameter. The surface is yellowish beige to ochre. Between the areoles, the hypothallus is grey. When present, apothecia are rounded or irregular in shape, and appear either singly or densely crowded on the substratum. They average 0.3-0.5 mm in diameter. The disc is beige to orange-brown, or olivaceous, flat to weakly convex in profile, and prunose when wet. *Lecanora densa* is primarily known from collections from high elevations in Arizona and Colorado. *L. densa* does not appear on ANHIC's Tracking and Watch List (Kemper 2009), or in the Natureserve database. This species was found once in the survey in a Labrador tea-subhygric black spruce-jack pine (g1) ecosite phase.

***Lecanora hybocarpa* – bumpy rim-lichen**

Lecanora hybocarpa is pale gray crust lichen with a typically bumpy thallus and apothecia with bumpy margins (although both may be smooth sometimes) (Brodo *et al*. 2001). The apothecia are 0.5-1 mm in diameter, with a disk that varies in colour from pale to orange- or reddish-brown. It has large crystals in the amphithecium and brown granules between paraphyses tips. This species grows on hardwoods and conifers. *L. hybocarpa* is ranked S1 (critically imperilled) in Alberta and G5 (secure) globally (Natureserve 2009). It was found once in the survey in a treed poor fen (j1).

***Lecidea leprarioides* – lecidea lichen**

Lecidea leprarioides is a crust lichen with a granular-sorediate thallus that is white, yellowish, grey, green and blue, often with the colours intermixed. It has black apothecia that are 0.3-0.5 mm wide, are matte and often bluish-pruinose, and have a thin, quickly receding proper rim. The upper hymenium is brownish blue-green. Its spores are non-septate and 6-12 x 2-4.5 µm. *L. leprarioides* is acidophilic and usually on grows on conifer wood, or less commonly on bark. This species does not appear on ANHIC's Tracking and Watch Lists (Kemper, 2009), and globally its status is GNR (not ranked). *L. leprarioides* was found four times in the survey, twice in treed bogs (i1), and once each in treed rich fen (k1) and blueberry aspen (b2) ecosite phases.

***Micarea denigrata* – dot lichen**

Micarea denigrata , also known as *Catillaria denigrata* or *C. synothea*, is a crust lichen with a thallus that is sometimes very thick but usually indistinct (Ozenda and Clauzade 1970). It forms apothecia that are 0.2-0.4 mm in diameter, black when dry, and dark greenish-brown when wet. The epithecium is greenish-black and confluent, and spores measure 7-14 x 2-3 µm. This lichen grows on the old wood of both coniferous and deciduous trees, and is known from Washington, Colorado, Newfoundland, Alberta, Greenland, and parts of Europe (Thompson 1997). *M. denigrata* is ranked SNR (not ranked) in Alberta and G2G4 (imperilled but likely apparently secure) globally. This species was found twice in the survey, in a shrubby, willow-dominated rich fen (k2) and in a Labrador tea-mesic jack pine-black spruce (c1) ecosite phase.

***Micarea misella* – dot lichen**

Micarea misella, also known as *Lecidea misella* or *L. asserculorum*, is a crust lichen growing on wood (Ozenda and Clauzade 1970). It has a geenish-grey thallus that is finely granular and may be indistinct. Apothecia are black with serrulate margins, quickly become convex, and measure 0.1-0.3 mm in diameter. Its epithecium is brown to blackish, and spores measure 7-12 x 2-3 µm. This species does not appear on ANHIC's Tracking and Watch Lists (Kemper, 2009), and globally its status is GNR (not ranked) (Natureserve 2009). This species was found once in the survey, in a willow-dominated shrubby rich fen (k2).

Mycobilimbia hypnorum – mycobilimbia lichen

Mycobilimbia hypnorum, also known as *Lecidea hypnorum*, is a crust lichen growing on mosses (Brodo *et al*. 2001). It has a pale, greenish thallus and reddish-brown apothecia with a smooth, prominent margin. The spores are elongate and ellipsoid and (1-)2 celled, and the paraphyses have narrow tips. This species is ranked S1 (critically imperilled) in Alberta and GNR (not ranked) globally (Natureserve 2009). *M. hypnorum* was found twice in the survey, once each in low-bush cranberry aspen (d1) and Labrador tea-horsetail white spruce-black spruce (h1) ecosite phases.

Nephroma bellum – naked kidney lichen

Nephroma bellum is a dull brown foliose lichen growing on branches and twigs, and occasionally mossy rock (Brodo *et al*. 2001). As a member of the genus *Nephroma*, it has apothecia (fruiting bodies) on the lower surface, extending from the lobe edges. *N. bellum* is characterized by a hairless lower surface, small (4-10 mm wide) lobes, and the absence of isidia, soredia, cephalodia, or warts. This species is ranked S2 (imperilled) in Alberta, SNR not ranked) in BC, however in Saskatchewan it is ranked S3S4 (likely secure) and G3G5 (vulnerable but likely secure) globally (Natureserve 2009, Kemper 2009). *N. bellum* was observed twice during the survey in dogwood balsam poplar-aspen (e1) and blueberry jack pine-aspen (b1) ecosite phases.

Omphalina umbellifera – greenpea mushroom lichen

Unlike most lichens, in which the fungal component of the lichen is an ascomycete (phylum Ascomycota), in *Omphalina umbellifera* the fungal component is a mushroom-forming basidiomycete (phylum Basidiomycota). *O. umbellifera* generally exists as a dark green globular crust on peat and rotting wood, but seasonally, small, yellow to yellow-orange mushrooms are produced. Although these mushrooms are similar to many other Alberta mushrooms, this is the only species that forms a lichen. *O. umbellifera* is ranked S1 (critically imperilled) in Alberta and Saskatchewan (Natureserve 2009); however, most references consider it common in the Pacific Northwest (Arora 1986, Phillips 1991), including Alberta (Schalkwijk-Barendsen 1991). It is likely under-reported because mushrooms are seasonal and not included as part of most surveys, and the green crust is fairly cryptic and not easily recognizable as a lichen. Its global status is GNR (not ranked). This species was found in 12 sites in a variety of ecosite phases (Table 5-10).

Peltigera conspersa – pelt lichen

Peltigera conspersa is a pelt lichen that is new to science and that will be more thoroughly described when it is formally published. *P. conspersa* was found once in the survey in a shrubby rich fen (k2).

Placynthiella uliginosa

Placyntheilla uliginosa is a granular crust lichen with a dark olive- to red-brown thallus growing on peaty or sandy soil, or less frequently on wood (Brodo *et al*. 2001). The granules are small, less than 0.15 mm in diameter. It has dark reddish brown to black apothecia that are 0.2-0.5 mm in diameter, have a rough surface, and a disc-coloured margin that disappears with age. It has a circumpolar arctic to northern temperate distribution, and in North America, this species occurs from Alaska, scattered througout western and central Canada, along the coast of Greenland and into the United States from the Great Lakes region to New England and south (Natureserve 2009). This species is ranked S2 (imperilled) in Alberta and G5 (secure) globally (Natureserve 2009). *P. uliginosa* was found once in a Labrador tea-mesic jack pine-black spruce (c1) ecosite phase.

Pseudevernia consocians – light and dark lichen

Pseudevernia consocians is typically found in east-central North America (Brodo *et al*. 2001). It has a fruticose growth habit (i.e. growing in a shrub-like manner from a central point) but its branches are foliose in that they are flattened and have differing upper and lower surfaces. It grows on conifers, primarily in forests. The lobes are thin (1-1.5 mm wide near the tips) and light grey, with an underside that is pale at the tips but darkens to blackish towards the centre. *P. consocians* differs from other members of the genus in having isidia, and sometimes marginal lobules, on the surface and margins of some of the lobes. This species is ranked S1 (critically imperilled) in Alberta (Kemper 2009); and G3G5 (currently vulnerable, but likely secure) globally. *P. consocians* was found once in a treed bog (i1) ecosite phase.

Pycnora leucococca

Pycnora leucococca, also identified as *Hypocenomyce leucococca*, is a small squamulose crust lichen, with a greenish brown to brown thallus, shiny, overlapping squamules less than 0.8 mm in diameter, and creamy white areoles that are granular sorediate at the edges (Brodo et. al 2001). It prefers old birches in partially shaded woodlands. *P. leucococca* is a boreal lichen that occurs in Canada, Norway, Austria, the Czech Republic, the U.K., and North America, where it is reportedly rare (Natureserve 2009). P. *leucococca* does not appear on ANHIC's All Lichen Element list (Kemper 2009) and globally this species is ranked G3? (vulnerable, but rank is questionable). *P leucococca* was found once in the survey in a treed bog (i1).

Ramalina dilacerata - punctured gristle

Ramalina dilacerata, also called *R. minuscula*, is a greenish-yellow shrub lichen with hollow, perforated branches lacking soredia that grows in a tufted form (Johnson *et al*. 1995, Vitt *et al*. 1988). It grows on stumps, trunks and branches of deciduous and coniferous trees and shrubs, most often in riparian areas (McCune and Geiser 1997, Johnson *et al*. 1995). Punctured gristle is found from Alaska to California and east into western Montana, in places with a strong oceanic influence (McCune and Geiser 1997). It is ranked S2 (imperilled) in Alberta, SNR in BC, and S3 (vulnerable) in Saskatchewan. Globally, its status is G3G5 (vulnerable but likely secure). *R. dilacerata* was observed in ten plots during the survey, in a variety of ecosite phases (Table 5-10).

Rinodina orculata – pepper spore lichen

Rinodia orculata is a crust lichen with a greenish-grey to reddish-brown, and a usually inconspicuous thallus that is thinly areolate (Foucard 2001, Spribille 2006). It has apothecia that are solitary to crowded, 0.2-0.4 mm wide, and have prominent, persistent rims coloured like the thallus. Its spores are dark gray brown and 14-18 x 6.5-9 µm, and the inner surface of the walls bulge into the outer ends of the lumina when the spores are developing. *R. orculata* does not occur on ANHIC's All Lichen Element list (ANHIC

2010) or in the Natureserve database (Natureserve 2009), but has been reported from Saguaro and Yellowstone National Parks in Arizona and Wyoming (Bennett and Wetmore 2008). This species was found once in the survey, in a horsetail balsam poplar-white spruce (f2) ecosite phase.

Trapeliopsis viridescens **– crustose lichen**

Trapeliopsis viridescens is a crust lichen consisting of minute, 0.1-0.2 mm diameter, smooth to powdery granules that are ashy grey to greenish (Fink 1910). It has apothecia that are often clustered and are 0.2-0.4 mm in diameter with margins that are the same colour as the thallus. The hymenium is brownish to purplish and the spores are oblong to ovoid and 9-13 x 4-5.5 µm. This species grows on old wood. T. viridescens does not appear on ANHIC's All Lichen Element list (ANHIC 2010), but is ranked G4G5 (apparently secure but likely is secure) globally.Natureserve (2009) reports T. viridescens to have a circumpolar boreal to temperate distribution that In North America ranges south to Alabama and California, and reaches the arctic above the treeline. It was found once in the survey, in a Labrador tea-mesic jack pine-black spruce (c1) ecosite phase.

Xylographa parallela **– black woodscript**

Xylographa parallela is a crust lichen growing on old wood. The thallus is immersed in the wood but stains it grayish (Brodo *et al*. 2001). It produces black to brown, long and slender soralia (called lirellae) that follow the wood's grain. The medulla under the lirellae reacts positively in potassium hydroxide and in *para*-phenylenediamine. Spores are one celled and hyaline. This species is ranked S2 (imperilled) in Alberta and Saskatchewan, and G5 (secure) globally (Natureserve 2009). *X. parallela* was found four times in the survey, in blueberry jack pine-aspen (b1), blueberry aspen (b2), Labrador tea-mesic jack pine-black spruce (c1), and treed rich fen (k1) ecosite phases.

Xylographa trunciseda **– woodscript lichen**

Xylographa trunciseda is a crust lichen with an immersed, greyish thallus growing on old wood (Poelt 1969). Its apotheicia, or lirellae, are soft and delicate-edged, reddish-yellow to brown, short-elliptical, and 0.2-0.25 mm long. Spores are 10-13 x 4-6 µm. This species does not appear on ANHIC's All Lichen Element list (ANHIC 2010), and is GNR (not ranked) globally. This species was found once in the survey, in a shrubby rich fen (k2).

5.3.3 Rare Plant Communities

There were no rare plant communities found within the PF or LSA.

5.3.4 Rare Plants in the Project Area

Thirteen rare plants (19 occurrences) and 4 plants that do not appear on ANHIC's All - Element Lists (ANHIC 2010) were observed within the PF (Figure 5-6). One was a vascular plant, four were bryophytes and 12 were lichens. The plants and the ecosite phase(s) in which they were found are listed in Table 5-10.

5.4 Biodiversity

5.4.1 LSA

Eleven ecosites and 24 ecosite phases were identified in the LSA. A total of 329 vascular and 302 non-vascular plant species (135 bryophyte species and 167 lichens) were identified in the LSA (Table 5-11). Forty-three rare plant species (152 occurrences) were identified in the area. Within ecosites, the highest total species richness values for both vascular and bryophyte species were found in ecosite k. The highest total species richness for lichens was found in ecosite i. Within ecosite phases, plot data was not collected within the LSA for ecosite phases b3, b4, and e3. Ecosite phase k2 had the highest total species richness, vascular plant, and bryophyte richness among the ecosite phases. Ecosite phase i1 had the highest total lichen species richness.

Table 5-11: Plant species richness by ecosite and ecosite phase in the LSA

	Total species	Unique species	Vascular	Non-Vascular		Rare plant	Non-native
				Bryophyte	Lichen		
Ecosite							
b	214	9	103	38	73	12	4
c	228	6	111	41	77	12	5
d	250	14	115	51	84	10	5
e	187	6	97	41	49	9	4
f	175	5	96	38	41	5	2
g	197	5	86	40	71	8	-
h	191	4	101	49	41	5	-
i	287	10	127	67	94	23	6
j	324	14	168	83	74	21	4
k	382	31	197	97	88	29	4
l	205	33	155	36	14	3	11
Ecosite Phase							
b1	178	4	95	34	49	4	3
b2	129	5	56	17	56	8	1
b3	-	-	-	-	-		-
b4	-	-	-	-	-		-
c1	228	6	111	41	77	12	5
d1	147	7	70	27	50	6	2
d2	185	4	94	32	59	2	3
d3	138	4	59	32	47	2	-
e1	171	5	84	39	48	7	3
e2	69	1	47	13	9	2	1
e3	-	-	-	-	-		-
f1	55	0	22	17	16	2	-
f2	132	4	81	26	25	1	1
f3	97	1	58	18	21	2	1
g1	197	5	86	40	71	8	-
h1	191	4	101	49	41	5	-
i1	237	5	95	59	83	14	4

	Total species	Unique species	Vascular	Non-Vascular Bryophyte	Non-Vascular Lichen	Rare plant	Non-native
i2	198	5	96	42	61	9	2
j1	263	7	133	67	63	13	-
j2	241	7	124	60	58	8	4
k1	241	7	114	63	64	9	-
k2	303	17	162	74	67	14	3
k3	156	7	96	41	19	6	1
l1	205	33	155	36	14	3	11

The number of sites sampled and the diversity parameters (mean richness, mean Shannon diversity index, mean evenness) are provided in Table 5-12 and Table 5-13 for ecosites and ecosite phases, respectively. Standard deviations for the mean are also shown. The highest mean species richness and diversity was found in ecosite e (mean=36.6 and 3.2 respectively) while the highest evenness (mean=1, rounded up) was found in ecosite h. The lowest values were found in ecosite i.

Ecosite phase e1 had the highest species richness (Table 5-13), followed by f2, f3, l1, d2, e2, and d1 all having more than 30 species on average. Graminoid rich fen k3 had the lowest species richness.

Table 5-12: Species Diversity of Ecosites in LSA

Ecosite	# of sites (n)	Species Richness		Shannon Diversity Index		Evenness	
		Mean	St Dev	Mean	St Dev	Mean	St Dev
b - blueberry	9	24.6	5	2.8	0.4	0.9	0.1
c - Labrador tea-mesic	5	26.3	2.9	2.9	0.5	0.9	0.1
d - low-bush cranberry	14	29.8	6.7	3.1	0.5	0.9	0.1
e - dogwood	4	36.6	10.1	3.2	0.7	0.9	0.2
f - horsetail	4	34	9.4	3	1.1	0.9	0.3
g - Labrador tea-subhygric	5	24.4	6.5	2.5	0.4	0.8	0.1
h - Labrador tea/horsetail	5	29.4	5.5	3.2	0.6	1	0.1
i - bog	10	19.8	4.1	2.1	0.6	0.7	0.2
j - poor fen	10	27	8.9	2.6	0.7	0.8	0.2
k - rich fen	16	22.4	6.3	2.3	0.6	0.7	0.2
l - marsh	4	33.7	11.2	2.4	0.4	0.7	0.1

Table 5-13: Species Diversity of Ecosite Phases in LSA

Ecosite Phase	# of Plots	Species Richness		Shannon Diversity Index		Evenness	
		Mean	SD	Mean	SD	Mean	SD
b1- blueberry Pj-Aw	6	21.9	4.6	2.6	0.4	0.9	0.1
b2- blueberry Aw(Bw)	3	28.5	2.3	3	0.1	0.9	0
b3- blueberry Aw-Sw	-	-	-	-	-	-	-
b4- blueberry Sw-Pj	-	-	-	-	-	-	-
c1- Labrador tea-mesic Pj-Sb	5	26.3	2.9	2.9	0.5	0.9	0.1
d1- low-bush cranberry Aw	5	30.6	5.5	3	0.5	0.9	0.1
d2- low bush cranberry Aw-Sw	5	33	5.8	3.3	0.5	1	0.1
d3- low bush cranberry Sw	4	22.7	4.6	2.8	0.4	0.9	0.1
e1- dogwood Pb-Aw	3	38.2	11	3.1	0.8	0.9	0.2
e2- dogwood Pb-Sw	1	31	0	3.4	0	1	0
e3- dogwood Sw	-	-	-	-	-	-	-
f1- horsetail Pb-Aw	1	17	0	1.3	0	0.5	0
f2- horsetail Pb-Sw	2	37.5	8.3	3.7	0.9	1	0.2
f3- horsetail Sw	1	35	0	2.4	0	0.7	0
g1- Labrador tea-subhygric Sb-Pj	5	24.4	6.4	2.5	0.4	0.8	0.1
h1- Labrador tea-horsetail Sw-Sb	5	29.4	5.5	3.2	0.6	1	0.1
i1- treed bog	5	19.7	5.2	2.4	0.7	0.8	0.2
i2- shrubby bog	5	20	2.8	1.9	0.3	0.6	0.1
j1- treed poor fen	5	28.2	6.2	2.8	0.6	0.8	0.2
j2- shrubby poor fen	5	24.8	12	2.1	0.7	0.7	0.1
k1- treed rich fen	5	27.7	3	2.7	0.4	0.8	0.1
k2- shrubby rich fen	6	21.3	4.5	2.3	0.4	0.7	0.1
k3- graminoid rich fen	5	13.6	2.1	1.5	0.4	0.6	0.1
l1- marsh	4	33.7	11.2	2.5	0.4	0.7	0.1

Biodiversity potential classes (very high – VH; high – H; moderate – M; low – L, and very low – VL) used are shown in Table 5-14 and Table 5-15. Biodiversity potential of all 24 ecosite phases was modeled separately for vascular and nonvascular species based on both species richness and on Shannon diversity index. Table 5-16 shows the total area of all ecosite phases combined for each of the five biodiversity classes. For vascular species the majority of the LSA is classified as very low or low in biodiversity potential, while the opposite is true for non-vascular species where high and very high classes comprise the majority of the area.

Table 5-14: Biodiversity Potential for Vascular Plants by Ecosite Phase.

Ecosite Phase	Richness Potential	Shannon's Diversity Index Potential
a1- lichen Pj	Low	Low
b1- blueberry Pj-Aw	High	High
b2- blueberry Aw(Bw)	High	Moderate
b3- blueberry Aw-Sw	Very high	Very high
b4- blueberry Sw-Pj	Very high	Very high
c1- Labrador tea-mesic Pj-Sb	Moderate	Low
d1- low-bush cranberry Aw	Very high	High
d2- low bush cranberry Aw-Sw	Very high	Very high
d3- low bush cranberry Sw	Very high	High
e1- dogwood Pb-Aw	Very high	Very high
e2- dogwood Pb-Sw	Very high	Very high
e3- dogwood Sw	Very high	High
f1- horsetail Pb-Aw	High	High
f2- horsetail Pb-Sw	Very high	High
f3- horsetail Sw	Very high	High
g1- Labrador tea-subhygric Sb-Pj	Low	Very low
h1- Labrador tea-horsetail Sw-Sb	Very high	High
i1- treed bog	Very low	Very low
i2- shrubby bog	Very low	Very low
j1- treed poor fen	High	Moderate
j2- shrubby poor fen	Low	Moderate
k1- treed rich fen	Very high	Moderate
k2- shrubby rich fen	Moderate	Low
k3- graminoid rich fen	Very low	Very low
l1- marsh	Moderate	Low

Table 5-15: Biodiversity Potential for Non-vascular Plants by Ecosite Phase.

Ecosite Phase	Richness Potential	Shannon's Diversity Index Potential
a1- lichen Pj	Moderate	Moderate
b1- blueberry Pj-Aw	Moderate	High
b2- blueberry Aw(Bw)	Moderate	High
b3- blueberry Aw-Sw	Moderate	Very high
b4- blueberry Sw-Pj	Low	Low
c1- Labrador tea-mesic Pj-Sb	High	Very high
d1- low-bush cranberry Aw	Very low	Very low
d2- low bush cranberry Aw-Sw	Low	Moderate
d3- low bush cranberry Sw	High	High
e1- dogwood Pb-Aw	Very low	Very low
e2- dogwood Pb-Sw	Low	Moderate
e3- dogwood Sw	High	Very high
f1- horsetail Pb-Aw	Very low	Low
f2- horsetail Pb-Sw	Low	High
f3- horsetail Sw	High	High
g1- Labrador tea-subhygric Sb-Pj	Very high	Very high
h1- Labrador tea-horsetail Sw-Sb	High	Very high
i1- treed bog	Very high	Very high
i2- shrubby bog	Very high	High
j1- treed poor fen	Very high	Very high
j2- shrubby poor fen	Very high	Very high
k1- treed rich fen	Very high	Very high
k2- shrubby rich fen	Moderate	High
k3- graminoid rich fen	Low	Moderate
l1- marsh	Low	Low

Table 5-16: Area And Percentage of Vascular and Non-Vascular Plant Biodiversity Potential in the LSA.

Potential Class	Biodiversity Potential for Vasculars				Biodiversity Potential for Non-Vasculars			
	Richness		Diversity		Richness		Diversity	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Very high	813.3	5.3	138.4	0.9	8682.4	56.5	9033.9	58.8
High	1614.6	10.5	1700.6	11.1	3531.7	23	5230	34
Moderate	4292.2	27.9	1912	12.4	2032.3	13.2	323.1	2.1
Low	3673.8	23.9	4292.2	27.9	352.8	2.3	24	0.2
Very low	4303.3	28	6659	43.3	103.1	0.7	91.2	0.6

Table 5-17 shows baseline fragmentation metrics for the LSA. Ecosite phase c1 has the greatest number of patches (25 % of the LSA), while ecosite phase b1 has the largest mean patch size (6.8 % of the LSA). The highest perimeter-area ratios were found in ecosite phases j1, j2, k2, and k3, and this is due primarily to their often elongated shapes that follow areas of low topography such as riparian margins (combined 17.5 % of the LSA).

Table 5-17: Fragmentation Metrics for Ecosite Phases in the LSA.

Ecosite Phase	Percent of LSA [%]	# of Patches	Patch Size		Perimeter-Area Ratio		Nearest Neighbour Distance	
			Mean [ha]	Range	Mean	Range	Mean [m]	Range
b1	6.8	39.0	26.7	217.3	487.9	1,499.0	327.5	5,128.9
b2	0.1	5.0	3.9	12.9	548.9	658.4	2,897.2	14,194.5
b4	0.1	1.0	8.6	0	231.9	0	N/A	N/A
c1	25.0	149.0	25.8	503.4	514.2	1,533.7	114.2	901.3
d1	0.5	17.0	4.8	14.8	459.2	1,011.8	777.3	2,270.3
d2	0.5	16.0	4.5	19.8	512.7	1,395.1	608.5	1,862.0
d3	0.6	18.0	5.0	22.6	471.0	809.6	447.8	1,867.4
e1	0.2	5.0	4.8	14.2	648.7	854.1	969.4	4,585.0
e2	0.2	5.0	4.7	18.3	710.9	792.5	681.7	1,576.3
e3	0.1	4.0	2.2	3.0	502.6	184.6	1,166.9	2,602.4
f1	<0.1	1.0	4.1	0	332.3	0	N/A	N/A
f2	0.1	2.0	8.7	0.3	404.7	143.7	648.6	0
f3	0.1	1.0	9.8	0	331.2	0	N/A	N/A
g1	14.5	103.0	21.7	375.4	491.7	1,513.6	170.2	1,685.7
h1	0.5	12.0	6.3	24.1	388.3	405.0	1,271.4	2,567.0
il1	6.2	150.0	6.3	90.6	566.4	1,504.1	187.8	1,535.3
i2	20.4	149.0	21.0	272.7	507.1	1,517.9	145.7	1,866.4
j1	2.4	72.0	5.2	34.1	587.8	1,470.7	335.2	2,360.0
j2	7.1	104.0	10.4	172.4	581.5	1,501.2	190.5	1,092.4
k1	2.7	46.0	9.0	66.2	435.2	1,075.3	513.9	5,219.3
k2	6.6	59.0	17.2	177.8	531.2	1,500.7	340.8	2,446.2
k3	1.3	56.0	3.7	56.1	761.2	1,437.3	428.5	4,975.6
l1	<0.1	2.0	1.6	1.3	461.0	144.8	2,470.3	0

Vegetation data have been converted from vector to raster format for use in Fragstats, resulting in changes to the number of patches and area of ecosite phases. Results used for fragmentation assessment only.

5.4.2 RSA

Table 5-18 shows the total area of all ecosite phases combined for each of the five biodiversity categories within the RSA. Similar to the LSA, the majority of the RSA is classified as very low or low in biodiversity potential for vascular species, while the opposite is true for non-vascular species where high and very high classes comprise the majority of the area.

Table 5-18: Area and Percentage of Vascular and Non-vascular Plant Biodiversity Potential for all Ecosite Phases Combined in the RSA.

Potential Class	Biodiversity Potential for Vasculars				Biodiversity Potential for Non-Vasculars			
	Richness		Diversity		Richness		Diversity	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Very High	4,998.1	8.7	675.1	1.2	34,219.4	59.6	33,699.4	58.7
High	5,047.9	8.8	6,193.7	10.8	11,412.3	19.9	18,343.8	31.9
Moderate	15,065.2	26.2	10,088.6	17.6	6,379.9	11.1	2,440.7	4.2
Low	13,686.1	23.8	15,065.2	26.2	2,510.6	4.4	104.5	0.2
Very Low	17,391.7	30.3	24,166.4	42.1	1,666.8	2.9	1,600.6	2.8

Table 5-19 shows baseline fragmentation metrics for the RSA. In the RSA, ecosite phase c1 has the largest number of patches (21.7 % of the RSA) and also the largest mean patch size of 37.9 ha. As expected, the ecosite phases with smaller number of patches have the largest nearest neighbour distances.

Table 5-19: Fragmentation Metrics for Ecosite Phases in the RSA at Baseline.

Ecosite Phase	Percent of RSA [%]	# of Patches	Patch Size		Perimeter-Area Ratio		Nearest Neighbour Distance	
			Mean [ha]	Range	Mean	Range	Mean [m]	Range
b1	3.3	65.0	28.9	335.1	487.4	1,513.2	568.1	5,605.6
b2	0.2	20.0	4.9	15.0	407.6	620.0	853.5	7,968.0
b4	<0.1	1.0	8.7	0	224.5	0	N/A	N/A
c1	21.7	329.0	38.0	1,864.2	410.4	1,536.4	115.7	1,063.8
d1	3.0	69.0	25.1	526.6	440.7	1,535.2	530.9	3,207.5
d2	0.9	53.0	10.1	250.0	460.7	1,534.2	558.7	3,950.8
d3	0.5	32.0	8.9	67.4	430.0	727.4	603.2	3,583.6
e1	0.1	11.0	5.3	23.2	577.3	713.9	1,423.9	4,585.0
e2	0.1	5.0	7.9	16.0	485.4	434.9	2,139.4	3,412.2
e3	<0.1	6.0	2.1	3.4	522.2	323.6	1,616.1	2,571.1
f1	0.1	11.0	4.9	10.4	498.1	626.8	3,967.4	16,140.6

Ecosite Phase	Percent of RSA [%]	# of Patches	Patch Size		Perimeter-Area Ratio		Nearest Neighbour Distance	
			Mean [ha]	Range	Mean	Range	Mean [m]	Range
f2	<0.1	9.0	2.9	8.8	572.3	658.8	424.2	1,965.1
f3	<0.1	1.0	9.9	0	334.2	0	N/A	N/A
g1	10.2	366.0	16.1	334.8	458.3	1,511.1	184.1	1,685.7
h1	0.4	43.0	5.4	41.6	503.7	1,424.0	834.7	3,922.6
i1	6.8	389.0	10.1	481.3	524.8	1,512.3	186.4	2,255.7
i2	20.4	392.0	29.8	1,201.4	480.6	1,530.1	136.5	1,185.2
j1	4.7	259.0	10.4	256.2	450.3	1,523.5	314.1	2,215.2
j2	10.6	305.0	20.0	640.9	488.2	1,506.1	194.0	1,328.6
k1	3.8	135.0	16.3	134.0	385.8	1,500.8	368.8	2,573.1
k2	8.1	250.0	18.6	481.6	583.4	1,483.9	204.7	2,481.1
k3	2.7	186.0	8.4	255.3	666.1	1,444.9	385.1	3,312.0
l1	<0.1	3.0	4.4	9.3	521.1	174.5	7,025.1	13,708.2

Vegetation data have been converted from vector to raster format for use in Fragstats, resulting in changes to the number of patches and area of ecosite phases. Results used for fragmentation assessment only.

6 ENVIRONMENTAL ASSESSMENT

The Project FTOR (AENV 2009) requires that the Environmental Assessment (EA) will define assessment scenarios including the Baseline Case, the Application Case which includes the Baseline Case with the effects of the Project added, and the Planned Development Case, which includes past, existing and anticipated future environmental conditions. The Baseline Case is presented in Section 5, and the Application Case is presented in this section (Section 6). The Application Case includes past and existing conditions (Baseline). Future and anticipated projects were reviewed for this assessment, and at this time, no developments other than what already exists within the study areas defined for the Project (PF, LSA, and RSA) have been identified. The only future activities that could be reasonably expected to occur would be timber harvesting. However, forestry will not return to the RSA for decades due to the 1995 wildfire that removed almost all of the merchantable timber. Future environmental conditions include natural disturbances (wildfire and climate change). The project is not located at or near the margins of the Boreal Forest Natural Region where potential effects due to climate change are expected to first appear. Combined with the relatively short lifespan of the project (approximately 30 years) climate change is not expected to impact vegetation and wetland resources during the life of the project. Fire is the single largest disturbance and has been included in the assessment of project effects on forest age class distribution (Section 5.1.1.7). Because of its stochastic nature it is not possible to spatially predict the effects of fire with any degree of accuracy. Therefore, the assessment of potential project effects is the same for both the Application Case and Planned Development (CEA) Case.

The Application Case describes the Baseline Case in combination with potential Project effects. Project effects are described at both maximum disturbance (construction and operation) and after mitigation (closure). Residual Project effects are determined after mitigation measures have been implemented.

Maximum disturbance assumes all Project facilities and infrastructure have been constructed and are operating simultaneously (Phases 1 to 3). While the Project will be implemented with phased construction of Project facilities, and sequential reclamation of well pads, borrow pits and associated facilities will be undertaken as bitumen resources are depleted, the location and timing of reclamation during operation will be dependent on reservoir performance, future core hole drilling and new technologies (Connacher 2009). Because future reclamation activities that will occur before Project closure are conceptual at this time, the conservative maximum disturbance scenario was used to assess Project effects.

For vegetation resources, mitigation will involve reclamation of disturbed communities following Project decommissioning. All Project facilities and infrastructure will have been decommissioned and removed, reclamation activities will have been completed and monitoring programs will have been established that will assess the return of the PF to equivalent land capability of pre-disturbance conditions. The Closure Scenario assesses Project effects after all mitigation measures have been applied. The Closure Scenario timeline was selected to allow for the succession of equivalent communities and commercial forests (50 years after Project closure) to become established. Fifty years is roughly equivalent to the natural fire return interval. Residual effects from the Closure Scenario have been evaluated in both a local (LSA) and regional (RSA) context.

6.1 Project Effects

The potential Project effects to vegetation and wetland resources are related to clearing natural vegetation and soils for Project facilities and infrastructure. Clearing natural vegetation will impact vegetation indicators directly through the reduction of communities and indirectly through changes to undisturbed vegetation and wetland resources resulting from changes to hydrology and habitat fragmentation. Other indirect effects considered in the assessment are effects to vegetation resulting from predicted climate change, natural disturbance (fire) and potential acid input (PAI). The potential effects of the Project have been assessed relative to each of the valued environmental components (VECs) described in Section 2.1, and the significance of Project effects for each VEC is summarized in Table 6-1.

Table 6-1: Summary of Impact Significance on Valued Environmental Components (VECs)

Valued Environmental Components											
Nature of Potential Impact or Effect	**Mitigation / Protection Plan**	**Type of Impact or Effect**	**Geographical Extent of Impact or Effect[1]**	**Duration of Impact or Effect[2]**	**Frequency of Impact or Effect[3]**	**Ability for Recovery from Impact or Effect[4]**	**Magnitude of Impact or Effect[5]**	**Project Contribution[6]**	**Confidence Rating[7]**	**Probability of Impact or Effect Occurrence[8]**	**Significance[9]**
1. Terrestrial Vegetation											
Reduction in area	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
2. Wetlands											
Reduction in Area	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Low	High	Insignificant
3. Old Growth Forests											
Removal of Old Growth forests	Yes	Application	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
		Cumulative	Local	Extended	Isolated	Reversible Long Term	Low	Neutral	High	High	Insignificant
4. Non-native and invasive species											
Invasions into cleared areas in the PF	Yes	Application	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
		Cumulative	Local	Extended	Periodic	Reversible Long Term	Low	Neutral	High	High	Insignificant
5. Traditionally Used Plants											
Removed from PF	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant

Valued Environmental Components											
Nature of Potential Impact or Effect	**Mitigation / Protection Plan**	**Type of Impact or Effect**	**Geographical Extent of Impact or Effect[1]**	**Duration of Impact or Effect[2]**	**Frequency of Impact or Effect[3]**	**Ability for Recovery from Impact or Effect[4]**	**Magnitude of Impact or Effect[5]**	**Project Contribution[6]**	**Confidence Rating[7]**	**Probability of Impact or Effect Occurrence[8]**	**Significance[9]**
6. Biodiversity											
Reduction in Genetic-Species Diversity	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	Moderate	High	Insignificant
Reduction of Community Diversity	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
Reduction of Landscape Diversity	Yes	Application	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant
		Cumulative	Local	Extended	Continuous	Reversible Long Term	Low	Neutral	High	High	Insignificant

1. Local, Regional, Provincial, National, Global
2. Short, Long, Extended, Residual
3. Continuous, Isolated, Periodic, Occasional, Accidental, Seasonal
4. Reversible in short term, Reversible in long term, Irreversible - rare
5. Nil, Low, Moderate, High
6. Neutral, Positive, Negative
7. Low, Moderate, High
8. Low, Medium, High
9. Insignificant, Significant

6.2 Impact Assessment

Where there has been no net effect to vegetation the Project contribution has been assessed as neutral. The assessment assumes that changes from wetland areas to upland or shrubland areas are irreversible. Prediction confidence is high where reclamation strategies have a high confidence for success (uplands) and low where there is a limited understanding that mitigation and reclamation strategies will reverse Project effects (peatlands).

6.2.1 Terrestrial Vegetation

6.2.1.1 Ecosite Phases

The area of ecosite phases and other land uses that will be disturbed in the LSA and RSA by the Project are summarized in Table 5-1. Construction and operation of the project will result in the removal of 3.3 % (511.4 ha) of the natural vegetation in the LSA (ecosite phases). The additional 9.4 ha that makes up the PF is existing anthropogenic disturbance, and this will be incorporated into the PF. The PF does not account for the Pod One and Algar developments (217.6 ha), however these will be reclaimed at the same time as areas of the PF, as resources are depleted. In the RSA, 0.9 % of the natural vegetation (ecosite phases) will be removed. The Project will also incorporate 22.1% of the existing industrial and anthropogenic land use in the RSA into the PF, including the Pod One and Algar developments.

Ecosite phases of limited distribution in the LSA that will be affected by the Project include d1, d2, d3, h1, and l1 (Table 5.-1). Within the RSA, ecosite phases of limited distribution that will be affected by the Project include d3, h1 and l1. In total, ecosite phases of limited distribution currently occupy 2.9% of the LSA (441.3 ha) and 1.6 % of the RSA (913.9 ha). The Project will result in the removal of 2.2 % of this area from the LSA and 1 % of this area from the RSA. None of the ecosite phases of limited distribution will be completely removed from the LSA or RSA, and a proportion of each are expected to be re-established during reclamation (Connacher 2010, Part E).

The removal of ecosite phases for the construction of Project facilities will result in a 3.4% change within the LSA, and a 0.9% change within the RSA. With the exception of marsh (l1), ecosite phases identified as limited in distribution within the LSA and RSA and that will be affected by the Project are not rare in the Boreal Mixedwood ecological area, and the area that is to be removed is very small (2.2 % LSA and 1 % RSA). With mitigation, there is an opportunity to re-establish these ecosite phases as larger portions of the original polygons will remain intact (Connacher 2010, Part E), and natural ingress of native species from the adjacent undisturbed polygons is expected to occur. While the marsh ecosite phase (l1) may be regionally limited in distribution, it is expected that an additional area of marsh will be created after reclamation. In particular borrow areas will be reconfigured and contoured with 3:1 slopes surrounding a central pond (Connacher 2010, Part E). This will result in at least a 3 m emergent zone (less than 1 m deep) with some ponds being entirely marsh depending on depth and water permanence. Assuming only a 3 m wide marsh zone, then approximately 15.9 ha of marsh will be created following reclamation at Project closure.

6.2.1.2 Rare Plants and Rare Plant Potential

Rare Plants in the PF

Descriptions of all rare plants found in the LSA are reported in Section 5.3.2, and their locations are presented on Figure 5-6 and in Appendix 8.

Construction and operation of the Project will result in the removal of rare plants observed within the PF. Fifteen rare plants (25 occurrences) were observed within the PF. One was vascular (two occurrences), five were bryophytes (six occurrences), and nine were lichens (17 occurrences). Of these, three are considered “critically imperiled” (S1) in Alberta, two are “most likely vulnerable” (S3?), one is “unrankable” (SU), two are “imperiled but most likely vulnerable” (S2S3) and five lichens are considered “imperilled” (S2). Globally, four are ranked “vulnerable but most likely secure” (G3G5), one is “most likely vulnerable” (G3?), one is “vulnerable” (G3), four are “not ranked” (GNR) or “unrankable” (GU), and five are globally “secure” (G5).

Also, four lichen species not previously described in Alberta were also identified within the PF (five occurrences). None of these species are listed on the Alberta Preliminary Lichen Tracking List (Kemper 2010), and they have not yet been assessed provincially. Although these species are not considered rare in Alberta at this time, they do have conservation value in the respect that data on their abundance and distribution in the province is unknown. Because the ANHIC Preliminary Lichen Tracking List has not been updated since 2000 (although the list has been republished, updates to the all lichen element list have not been made since 2000), providing information about these new species to ANHIC will help update the list when revisions are made. Of the rare plants observed in the LSA, all but four species have been found outside of the PF as well. No rare plant communities were observed during the survey.

All but the vascular species and a few of the rare bryophytes and lichens reported in the rare plant survey are not field identifiable species and require a microscope and special stains for positive identification. The involvement of a lichen specialist in the Project rare plant survey resulted in considerably more “rare” lichens being found than with similar surveys. The locations of the lichens are approximate and mark the starting point for the rare plant wander searches (Section 4.3.2) that may cover 1000 m^2 or more. Within the wander the surveyors were asked to select one or two representative areas and sample for small inconspicuous species. This involved crawling on hands and knees and collecting anything that could not be identified. Because this level of sampling is generally not done outside of academic studies, and the results are not consistently reported to tracking bodies (e.g., ANHIC), reports of abundance and distribution of these species is at best incomplete (Natureserve 2009). Also, because S-ranks are largely determined by the number of times a species is detected in the province, low profile and hard to identify species are more likely to be listed as rare (ABMI 2007). Therefore, it is impossible to determine if the species are in fact rare, are at the edge of their natural range and only appear to be rare, or are taxonomically uncertain having been previously misidentified or described as subspecies. Many of these species were found a number of times outside the PF. The multiple occurrences of several of the species supports the conclusion that many of these small inconspicuous species present on the tracking lists are in fact not rare. Because it is not possible to identify these species in the field, and they often have specific microclimate requirements, transplanting is not an option. Modification of the project footprint is also not practical as subsequent rare plant searches, if conducted in the same way, would likely find more examples of these small inconspicuous and underreported species.

The only rare vascular species found in the survey was *Chrysosplenium iowense.* This species is provincially and globally ranked most likely vulnerable (S3?, G3?). Because this species was found eight times outside of the PF, and is frequently found in saturated areas along seismic lines and other disturbances in the Boreal Mixedwood ecological area, no other mitigation is recommended for this species other than reporting these observations to ANHIC and minimizing disturbance outside of the PF.

Also, it is recommended that all occurrences of non-vascular species be reported to ANHIC for updating of the tracking lists, and that disturbance to potentially suitable habitat adjacent to rare plant locations be minimized by making the Project footprint as small as is practical. Due to historical underreporting of bryophytes and lichens, reporting of these findings, and others in the area, to ANHIC is likely to result in some reclassification of the species described here. No additional mitigation for these species is recommended.

Rare Plant Potential

The potential of each ecosite phase observed in the study areas to support rare plants is presented in Section 5.1.1.4. Construction and operation of the Project will result in the removal and reduction of 3.3 % (476.1 ha) of ecosite phases with high and very high rare plant potential in the LSA, and 0.7% in the RSA. The majority of the rare species that characterize these sites as having high and very high rare plant potential are bryophyte and lichen species.

Reclamation activities at Project closure will focus on the re-establishment of ecosites c and g. In time, as these reclaimed ecosites begin to function like mature Labrador tea – mesic and hubhygric sites, it is expected that the potential for these sites to support rare plants will increase. The reestablishment of natural disturbances, particularly fire, will aslo help restore natural function and diversity.

6.2.1.3 Forestry Resource

Forested land represents 74 % of the LSA and 60 % of the RSA. The Project will result in the removal of 3.8% of forested land from the LSA, and 1.2 % from the RSA. Productive land (TPR – good, moderate, and fair) represents 96 % of the forested area in the PF, and the merchantable timber volume is 2,714 m^3. Construction of the Project will remove all timber from the PF. The volume of timber in the study areas is low relative to the productive area, and this is because the standing timber that remains is remnant patches that survived the 1995 fire, with the remaining forest area consisting of natural postfire regeneration. Due to the 1995 fire, Project effects on Annual Allowable Cut (AAC) will be minimal and confined to loss of growth only within the PF. All merchantable timber salvaged from the project will be made available to the FMA holder (Al-Pac).

6.2.1.4 Potential Acid Input and Nitrogen Deposition

Application case scenario nitrogen deposition ranges from 0.65 kg ha^{-1} yr^{-1} to 2 kg ha^{-1} yr^{-1}. Nitrogen deposition is predicted to remain well below even the most conservative critical deposition rates for sensitive ecosystems (Bobbink and Roelofs 1995, WHO

2000), and is not expected to have an effect on vegetation or plant communities. Similarly, PAI was not found to significantly effect soils (MEMS 2010a), and therefore no indirect effects on vegetation or plant communities is expected.

6.2.1.5 Post-Reclamation Ecosites

Areas disturbed by construction activities will be progressively reclaimed to minimize post-construction effects such as soil erosion. Once facilities are removed and the Project components are completed, final site grading and re-contouring will take place to achieve near-natural drainage patterns and topography.

On sites with a low degree of disturbance (seismic lines, power lines, winter roads), natural recovery is expected to redevelop native plant communities similar to adjacent undeveloped areas and facilitated revegetation (planting) of these areas will not occur unless conditions warrant. On sites with a higher degree of disturbance, short-lived agronomic crops will be seeded to quickly establish cover to provide soil stability and prevent soil erosion. Natural ingress of native herbaceous plants, shrubs, and trees will be supplemented by the planting of appropriate tree species common to pre-disturbance ecosites. An adaptive management approach, including non-native and invasive species control and monitoring, and revegetation assessments, will be used to ensure that the site has been reclaimed to an equivalent pre-disturbance land capability.

Reclamation will be focused on maintaining distributions of ecosites, not ecosite phases. Ecosite is defined by the site conditions (moisture and nutrient regimes) relative to the regional climate. Ecosite phase, that includes the plant community, naturally changes with time (succession) and initially after reclamation may not be representative of the future composition.

It is expected that the reclaimed upland areas will become primarily blueberry (b), Labrador tea-mesic (c) and Labrador tea-subhygric (g) ecosites over time. Current revegetation practices in the Oil Sands Region include the planting of pine and black spruce seedlings, and other woody species such as shrubs, after the establishment of a seeded agronomic ground cover. Initially, the small size and spacing of planted trees will result in open meadow like conditions that do not resemble the mature Labrador tea-mesic (c) and Labrador tea-subhygric (g) ecosites that will eventually develop. However, over time and as the canopy closes, native herbaceous vascular and bryophyte species are expected to establish on the upland forested areas as the sites come to resemble and function like mature c and g ecosites.

Vegetation assessments will be completed on the reclaimed lands and will provide an indication of the types of ecosites that are expected to develop after seeding and will represent different successional stages in the development of ecosite phases. Initially, these will be dominated by annual graminoid and legume species that will have persisted since the initial seed mix was applied.

Within the LSA, reclaimed areas were assigned the expected ecosites based on landscape position and soil conditions. Initially, reclaimed ecosite will have a different understory species composition compared to naturally occurring ones, due to the initial application of the soil stabilizing seed mix. With time, planted trees will exert an influence on the understory microclimate conditions and ecosystem function, and as the canopy closes, the coverage of native species will increase.

Based on the anticipated reclamation topography and management practices, reclaimed areas adjacent to wetland ecosite phases are expected to have an emergent vegetation zone that will act as a transition zone between open water and existing wetland ecosite phases. This emergent zone best resembles the marsh ecosite phase (l1). Vegetation typical of this ecosite phase (cattail, reed grass, and sedges) will quickly establish on the submerged and saturated mineral soil along the margins of these reclaimed wetland ecosite phases.

6.2.1.6 Summary of Impact Significance

Project-specific effects on Terrestrial Vegetation are expected to be minimal with mitigation. For both the LSA and RSA, Project effects on terrestrial vegetation are related to the reduction in area of individual ecosite phases, removal of rare plants and potential rare plant habitat, and removal of forest resources. Application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is certain, and overall, the Project effect is **insignificant**.

6.2.2 Wetlands

The area of AWIS wetlands that will be affected in the LSA and RSA by the Project are summarized in Table 5-9. Construction and operation of the project will result in the removal of 2.5 % (190.1ha) of the existing wetland types in the LSA. The Project will remove 3.1 % (128.3 ha) of existing BTNN, 2.2 % (20.3 ha) of FONS, 1.7 % (38.5 ha) of FTNN, and 1.7 % (0.1 ha) of MONG from the LSA. In the RSA, 0.6% (190.1ha) of the existing wetland types will be removed. The Project will remove 0.8 % of existing BTNN, 0.5 % of FONS, and 0.5 % of MONG wetland types from the RSA.

AWIS wetland types of limited distribution in the LSA and RSA that will be affected by the Project are the MONG type (1.7 % and 0.5 %, respectively) and SFNN type (0.1% in both). In total, wetland types of limited distribution currently occupy 0.7 % of the LSA (113.9 ha) and 1.1 % of the RSA (658.1 ha). The Project will result in the removal of 0.2 % of this area from the LSA and <0.1 % of this area from the RSA. None of the AWIS wetland types of limited distribution will be completely removed from the LSA or RSA.

Peatlands represent an important wetland type in the Boreal Mixedwood ecological area as these wetland types are difficult to reclaim and are slow to recovery after disturbance. Peatlands affected by the Project represent 2.5 % (190 ha) of all peatlands in the LSA, and 0.6 % in the RSA.

Project-specific effects on wetlands are expected to be minimal with mitigation. The removal of AWIS wetland types for the construction of Project facilities will result in a 2.5 % change within the LSA, and a <0.1 % change within the RSA, after mitigation (reclamation). Both the MONG and SFNN are limited in distribution within the LSA and RSA and will be affected by the Project, and both are considered to be limited in distribution in the Boreal Mixedwood ecological area. Due to the very small area of disturbance proposed within these wetlands (0.2 ha), with mitigation it is expected that an equivalent area of each will be re-established at Project closure. It is also proposed that an additional 15.8 ha of MONG will be created during reclamation (Connacher 2010, Part E).

The Project will result in a small reduction of peatlands in the LSA and RSA (2.5 % and 0.6% respectively). With mitigation measures that include the maintenance of drainage patterns to wetlands and minimizing of the construction footprint, the effect of the reduction of peatland area as a result of the Project is expected to be negligible. During construction, peat and topsoil materials will be salvaged and stored for replacement during reclamation.

6.2.2.1 Summary of Impact Significance

Within the LSA, Project effects on wetlands are related to the reduction in area of individual wetlands, including peatlands (approximately 2.5% of the LSA). Project effects are expected to be minimal with mitigation and monitoring. Application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is low because of the uncertainty in reclaiming peatlands, the probability of the effect is high, and overall, the Project effect is **insignificant**.

6.2.3 Old Growth Forests

The total amount of old growth forest is 30.7 ha in the LSA and 257 ha in the RSA. The Project will result in the removal of 2.0 % (0.6 ha) of old growth in the LSA, and 0.2 % of the RSA. The old growth in the PF is a small, open, remnant patch of aspen with less than 30% crown closure, which survived the 1995 fire.

6.2.3.1 Age Class Distribution

The predicted forest age class distribution 80 years into the future continues to show the effect of the 1995 wildfire that burned much of the RSA. The small size and short duration of the project, relative to the natural boreal forest disturbance regimes, results in an insignificant difference between the expected age distribution (modeled) with and without the project (Figure 6-1). As expected, the amount of old growth within the RSA will remain low during the application case and well into the future as a result of the 1995 wildfire. When allowed to run for 120 years, the model predicts that the amount of old growth will be above the expected natural range of variation. This is an artifact of the model however, because the stochastic nature of wildfire makes specific predictions impossible, and the model is intended to represent the entire landscape not any specific piece of it.

6.2.3.2 Old Growth Potential

Within the LSA, construction and operation of the project will result in the removal of 0.7 % (0.6 ha) of ecosite phases with high potential to support old growth, and 1.3 % of ecosite phases with moderate potential. In the RSA, this will result in the removal of <0.1% of ecosite phases with high potential to support old growth, and 0.2 % with moderate potential. Reduction in area of ecosite phases with high and moderate potential within the Project study areas will be negligable.

The amount of old growth and ecosite phases with the potential to support old growth forests that are to be removed from the LSA is negligible and will not have an effect on the ability for these forests to regenerate after Project closure. As the model of future age class distribution shows, there will be no difference in the development of old age class forests with or without the Project.

6.2.3.3 Summary of Impact Significance

Within the LSA, Project effects on old growth stands are related to the reduction in area of old growth, and a reduction in ecosite phases with the potential to support the development of these stands. Due to the wildfire history in the Project study areas, the Project is expected to have a negligible effect on old growth forests. Application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is **insignificant**.

6.2.4 Non-native and Invasive Species

Sixteen non-native and invasive plants were found in the LSA (61 occurrences) and five were found in the PF (ten occurrences). Appendix 4 lists the species found and their observed locations within the study areas. Species found include noxious, nuisance, and agronomic invasive species. No provincially restricted species were observed in the LSA. Although non-native and invasive species are already prevalent within the study areas, construction and operations activities may increase the spread and establishment of these species into areas adjacent to disturbed sites. Non-native and invasive plants can reduce or displace native species and may alter some ecosystem functions (Hobbs and Huenneke 1992). The removal of litter and increased bare ground can enhance establishment of invasive annual forbs and non-native species (Hayes and Holl 2003).

With mitigation (including a weed management and monitoring program), the Project is not expected to have a local or regional effect on the establishment and spread of non-native and invasive species.

6.2.4.1 Summary of Impact Significance

Potential Project effects are related to the establishment and spread of non-native and invasive species resulting from construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, periodic in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is **insignificant**.

6.2.5 Traditionally Used Plants

Ecosite phases with the potential to support traditionally used plants that will be affected in the LSA and RSA by the Project are summarized in Table 5-7. Ecosite phases with the potential to support berry plants are presented in Table 5-8.

Construction and operation of the project will result in the removal of 2.3% (6.9 ha) of ecosite phases with high traditional plant potential from the LSA and 0.3 % from the RSA. Also, 3.4 % (454.2 ha) of ecosite phases with moderate potential will be removed from the LSA and 0.9% from the RSA. The total area of ecosite phases with high and moderate potential to support traditionally used plants that will be removed is 3.4%

(461.1 ha) from the LSA and 0.9 % from the RSA. The total area of ecosite phases with the potential to support berry communities that will be removed is 3.7 % (486.2 ha) from the LSA and 1.0 % from the RSA.

Ecosite phases with the potential for blueberries, bog cranberries, chokecherry, currants, gooseberries, low-bush cranberries, pin cherries, saskatoons, raspberries, and strawberries are upland sites and will be reclaimed to upland sites similar to baseline conditions (Connacher 2010, Part E). Overall, the amount of ecosite phases with the potential to support traditionally used plants (including berry habitat) that will be removed as a result of the Project is very low relative to the amount that will still be accessible in the LSA and RSA. With mitigation, the Project is not expected to have an lasting local or regional effect on traditional plants.

6.2.5.1 Summary of Impact Significance

Potential Project effects are related to the removal of traditionally used plants resulting from construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is **insignificant**.

6.2.6 Biodiversity

The biodiversity VEC was assessed at three levels. Species biodiversity was assessed to address the effect of removing plant species from the LSA. Community biodiversity was assessed to address the effect of removing ecosite phases or biodiversity potential (based on ecosite phases) from the LSA. Landscape biodiversity was assessed to address the effect of the Project on biodiversity in the RSA.

6.2.6.1 Species Diversity

Construction and operation of the Project will result in the removal of approximately 2.2 % (53.9 ha) of ecosite phases with very high and high vascular species biodiversity potential (based on species richness) from the LSA, and 0.9 % from the RSA. Based on non-vascular species richness, the Project will result in the removal of 3.7 % (454.1 ha) of habitat with very high and high biodiversity from the LSA and 1 % from the RSA. Within the LSA and RSA, most of the area with very high and high vascular species biodiversity potential is comprised of ecosite phases d1, d2, d3, and k1 (1.9 % of the PF). The majority of the area with very high and high non-vascular species biodiversity potential is comprised of ecosite phases c1 and g1 (54 % of the PF).

As expected the mean species richness results generally reflect the nutrient and moisture regime, interspecific competition, and successional patterns that are characteristic of ecosite phases present in the LSA. For example, high species richness was found in e and f ecosite phases, likely because these phases are moist, nutrient rich, and are very productive. Lower species richness in i ecosite phases reflects poor nutrient regime, and in the k3 ecosite phase, competition from abundant graminoid species accounts for lower species richness.

After closure, species richness is expected to be lower than naturally developing ecosites. The current Connacher reclamation practice is to seed annual grass and legume species to stabilize reconstructed soils and to minimize sedimentation. Since these species are quick to establish and form a dense turf layer, native species ingress and regeneration will be initially limited due to competition. Native species cover will increase over time.

Considering both vascular and non-vascular species richness, construction and operation will result in the removal of 5 % of the ecosite phases with very high and high biodiversity potential in the LSA, and 0.9 % in the RSA. Measures taken to mitigate for the reduction in area of terrestrial vegetation (VEC 1), wetlands (VEC 2), old growth forests (VEC 3), and non-native and invasive species (VEC 4) will effectively mitigate for potential Project effects on species level biodiversity. In particular the reestablishment of c and g ecosites means that the Project is expected to result in a negligible effect on biodiversity potential and overall species richness.

6.2.6.2 Community and Landscape Diversity

Fragmentation was considered in the assessment of community and landscape level biodiversity. As reported in Section 3.1.4, the effects of low impact 3D seismic exploration were assessed in the 2007 application for the Algar development. No lasting effects to vegetation and wetland resources were found as a result of the 3D seismic (Connacher 2007), and therefore, 3D seismic was not included in the Project fragmentation analysis (i.e., no residual 3D seismic effects are expected to be present 20 years after Project start which is the maximum disturbance scenario). Table 6-2 and Table 6-3 show the predicted Project effect related to fragmentation within the LSA and RSA, respectively. The numbers shown are for the maximum disturbance scenario (construction and operation of all three phases of the Project) and do not include reclamation or restoration described in the Conservation and Reclamation plan (Connacher 2010, Part E). The irregular shape of the mapped areas results in differences in the number of disturbed patches between the LSA and RSA.

Overall, the project will result in an increase in the number of patches and a decrease in patch area per ecosite phase in both the LSA and RSA. Ecosite phases with the highest level of fragmentation include b1, c1, d3, g1, h1, and i2 in the LSA. Within the RSA, ecosite phases with the highest level of fragmentation include those in the LSA as well as k1 and k2 ecosite phases. Of these, only ecosite phases d3 and h1 are of limited distribution. Neither of these are limited in distribution in the Boreal Mixedwood ecological area. Fragmentation of the LSA and RSA is due to the linear nature of the Project that bisect individual patches into smaller patches. None of the ecosite phases that will be fragmented by the Project will be completely removed from the LSA or RSA.

For the landscape as a whole the Shannon diversity index (calculated using patches not species) is 2.36 with the project (Application Case) and 2.28 without the project (Baseline) for the LSA. For the RSA, the landscape level Shannon diversity index is 2.38 with the project and 2.35 without the project.

Upland ecosite phases occupy 31.2 % (4801.9 ha) of the LSA and 27.2 % (15633.8 ha) of the RSA. Lowland ecosite phases represent 64.4 % (9900.2 ha) of the LSA and 70.6 % (40,555.1 ha) of the RSA. Wetland ecosite phases occupy 50 % (7692.8 ha) of the LSA and 59 % (33,907.9 ha) of the RSA. Construction and operation of the Project will result in the removal of 3.9 % (185.9 ha) of upland ecosites in the LSA and 1.2 % in the RSA. The Project will also remove 4.2 % (331.2 ha) wetland ecosites in the LSA, and 1.0 % of wetland ecosite phases in the RSA. Regionally, the project will have a negligible impact on community level biodiversity as most of the ecosite phases that will be affected are common in the region. Although the Project will result in the removal of ecosite phases and AWIS wetlands that are locally and regionally limited in distribution (Section 6.2.1 and Section 6.2.2), only marshes and forested swamps (ecosite phase I1 and hygric or wetter forms of ecosite phase g1, AWIS wetlands SFNN and MONG) are limited in distribution within the Boreal Mixedwood ecological area. With mitigation (reclamation), it is expected that 15.8 ha of marsh (MONG) will be added and an equivalent area of SFNN will be restored at Project closure, and considering the limited amount of each wetland type that will be affected by the Project (0.2 ha), the magnitude of the effect will be ameliorated by reclamation at closure.

In the maximum disturbance scenario (without mitigation shown in Table 6-2), Project effects related to the change in patch number and area within ecosite phases c1, g1, and i2 will increase in the LSA. This is due to the change in patch number that in turn impacts mean patch area and all other measures of fragmentation. However, following mitigation the Project will have a negligible impact on community and landscape level biodiversity within the LSA or RSA. No ecosite phase will be lost or added to the LSA or RSA as a result of the project. As well, because the Project will be developed in phases with sequential reclamation occurring throughout the life of the project (Connacher 2010, Part E) the actual maximum expected impact is much less than shown in Table 6-2 and Table 6-3. The small size of the PF (520.8 ha) relative to the RSA (57458.4 ha) means that regional Project effects will also be minimal.

Project effects related to biodiversity will be addressed by measures taken to mitigate for the reduction in area of terrestrial vegetation (VEC 1), wetlands (VEC 2), old growth forests (VEC 3), non-native and invasive species (VEC 4), and traditionally used plants (VEC 5). In particular the re-establishment of c and g ecosites (Connacher 2010, Part E) means that the Project will have a minimal effect on community and landscape level biodiversity.

Table 6-2: Predicted Project Effects on Fragmentation Metrics for Ecosite Phases in the LSA.

Ecosite Phase	Number of Patches			Patch area			Perimeter-Area Ratio			Nearest Neighbour Distance		
	Baseline	Construction and Operation		Baseline	Construction and Operation		Baseline	Construction and Operation		Baseline	Construction and Operation	
		Application	Change		Application	Change		Application	Change		Application	Change
b1	65	81	16	28.9	22.8	-6.2	487.4	554.8	67.4	568.1	450.9	-117.2
b2	20	20	0	4.9	4.9	0.0	407.6	407.6	0.0	853.5	853.5	0.0
b4	1	1	0	8.7	8.7	0.0	224.5	224.5	0.0	N/A	N/A	N/A
c1	329	402	73	38.0	30.6	-7.3	410.4	497.4	87.0	115.7	106.4	-9.3
d1	69	69	0	25.1	25.1	0.0	440.7	441.4	0.7	530.9	531.4	0.5
d2	53	54	1	10.1	9.9	-0.2	460.7	478.6	18.0	558.7	555.0	-3.6
d3	32	34	2	8.9	8.3	-0.7	430.0	509.8	79.7	603.2	575.9	-27.3
e1	11	11	0	5.3	5.3	0.0	577.3	577.3	0.0	1,423.9	1,423.9	0.0
e2	5	5	0	7.9	7.9	0.0	485.4	485.4	0.0	2,139.4	2,139.4	0.0
e3	6	6	0	2.1	2.1	0.0	522.2	522.2	0.0	1,616.1	1,616.1	0.0
f1	11	11	0	4.9	4.9	0.0	498.1	498.1	0.0	3,967.4	3,967.4	0.0
f2	9	9	0	2.9	2.9	0.0	572.3	572.3	0.0	424.2	424.2	0.0
f3	1	1	0	9.9	9.9	0.0	334.2	334.2	0.0	N/A	N/A	N/A
g1	366	426	60	16.1	13.5	-2.6	458.3	504.4	46.2	184.1	161.5	-22.6
h1	43	47	4	5.4	4.9	-0.5	503.7	522.6	18.9	834.7	772.0	-62.7
i1	389	413	24	10.1	9.4	-0.7	524.8	547.0	22.2	186.4	179.6	-6.8
i2	392	438	46	29.8	26.6	-3.3	480.6	519.9	39.4	136.5	125.7	-10.8
j1	259	262	3	10.4	10.2	-0.1	450.3	456.5	6.3	314.1	309.6	-4.5
j2	305	324	19	20.0	18.8	-1.3	488.2	520.3	32.1	194.0	186.4	-7.7
k1	135	140	5	16.3	15.7	-0.6	385.8	406.1	20.2	368.8	340.1	-28.6
k2	250	270	20	18.6	17.2	-1.5	583.4	587.8	4.4	204.7	190.1	-14.7
k3	186	188	2	8.4	8.3	-0.1	666.1	671.9	5.8	385.1	375.6	-9.5
l1	3	3	0	4.4	4.3	-0.1	521.1	547.7	26.7	7,025.1	7,025.1	0.0
Total	**2940**	**3215**	**275**	**297.2**	**272.1**	**-25.1**	**10,912.8**	**11,387.8**	**475.0**	**22,634.8**	**22,309.9**	**-324.9**

Vegetation data have been converted from vector to raster format for use in Fragstats, resulting in slight changes to the number of patches and area of ecosite phases. Results used for fragmentation assessment only.

Table 6-3: Predicted Project Effects on Fragmentation Metrics for Ecosite Phases in the RSA.

Ecosite Phase	Number of Patches			Patch area			Perimeter-Area Ratio			Nearest Neighbour Distance		
	Baseline	Construction and Operation		Baseline	Construction and Operation		Baseline	Construction and Operation		Baseline	Construction and Operation	
		Application	Change		Application	Change		Application	Change		Application	Change
b1	39	52	13	26.7	19.4	-7.4	487.9	548.1	60.2	327.5	242.7	-84.8
b2	5	5	0	3.9	3.9	0.0	548.9	548.9	0.0	2,897.2	2,897.2	0.0
b4	1	1	0	8.6	8.6	0.0	231.9	231.9	0.0	N/A	N/A	N/A
c1	149	217	68	25.8	16.9	-8.9	514.2	615.2	-101.0	114.2	97.7	-16.5
d1	17	17	0	4.8	4.7	0.0	459.2	461.3	-2.1	777.3	779.9	2.6
d2	16	17	1	4.5	4.1	-0.4	512.7	544.2	-31.6	608.5	588.2	-20.3
d3	18	20	2	5.0	4.3	-0.7	471.0	607.8	-136.8	447.8	417.1	-30.7
e1	5	5	0	4.8	4.8	0.0	648.7	648.7	0.0	969.4	969.4	0.0
e2	5	5	0	4.7	4.7	0.0	710.9	710.9	0.0	681.7	681.7	0.0
e3	4	4	0	2.2	2.2	0.0	502.6	502.6	0.0	1,166.9	1,166.9	0.0
f1	1	1	0	4.1	4.1	0.0	332.3	332.3	0.0	N/A	N/A	N/A
f2	2	2	0	8.7	8.7	0.0	404.7	404.7	0.0	648.6	648.6	0.0
f3	1	1	0	9.8	9.8	0.0	331.2	331.2	0.0	N/A	N/A	N/A
g1	103	158	55	21.7	13.2	-8.4	491.7	576.3	-84.6	170.2	116.7	-53.5
h1	12	16	4	6.3	4.5	-1.8	388.3	449.2	-60.9	1,271.4	973.9	-297.5
i1	150	176	26	6.3	5.1	-1.2	566.4	620.3	-53.9	187.8	169.1	-18.7
i2	149	196	47	21.0	15.7	-5.3	507.1	585.6	-78.6	145.7	117.4	-28.4
j1	72	77	5	5.2	4.7	-0.4	587.8	608.3	-20.5	335.2	310.0	-25.2
j2	104	120	16	10.4	8.8	-1.6	581.5	627.6	-46.2	190.5	176.6	-13.9
k1	46	51	5	9.0	8.0	-0.9	435.2	477.9	-42.7	513.9	420.0	-93.9
k2	59	80	21	17.2	12.4	-4.8	531.2	565.5	-34.3	340.8	233.5	-107.3
k3	56	59	3	3.7	3.5	-0.2	761.2	787.9	-26.7	428.5	389.2	-39.3
l1	2	2	0	1.6	1.5	-0.1	461.0	502.0	-41.0	2,470.3	2,470.3	0.0
Total	**1,016**	**1,282**	**266**	**215.8**	**173.7**	**-42.2**	**11,467.5**	**12,288.7**	**-700.7**	**14,693.3**	**13,866.0**	**-827.3**

Vegetation data have been converted from vector to raster format for use in Fragstats, resulting in slight changes to the number of patches and area of ecosite phases. Results used for fragmentation assessment only.

6.2.6.1 Summary of Impact Significance

Species Diversity

Potential Project effects are related to the reduction of species diversity resulting from vegetation clearing during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is moderate, the probability of the effect is high, and overall, the Project effect is **insignificant**.

Community Diversity

Potential Project effects are related to the reduction of community diversity resulting from the removal of ecosite phases from the LSA during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is **insignificant**.

Landscape Diversity

Potential Project effects are related to the removal of landscape diversity resulting from removal or alteration of ecostie phases in the RSA during construction and operation of the Project. With mitigation, application case effects are local in extent, extended in duration, continuous in frequency, reversible in the long term, of low magnitude, and have a neutral contribution. The confidence rating of the assessment is high, the probability of the effect is high, and overall, the Project effect is **insignificant**.

7 MITIGATION AND MONITORING

Mitigation will focus on minimizing the PF footprint and establishing vegetation and wetland community environments to have equivalent capabilities to the pre-disturbance conditions. Additional mitigation will focus on minimizing effects to rare plants and reducing the introduction of non-native and invasive species. Existing disturbance areas (anthropogenic land uses) will be used in the development of the Project when possible to minimize the clearing of natural vegetation. In many instances fill material will be removed to facilitate the establishment of pre-disturbance conditions: During the life of the Project, reclamation of development and construction areas that are no longer required (well pads, borrow pits and associated infrastructure) will be ongoing. Reclaimed vegetation and wetland communities will be designed to incorporate key habitat variables for wildlife, and traditional, cultural, and recreational uses. Final reclamation design will be completed in consultation with AENV, ASRD and local stakeholders. Reclamation strategies are described in greater detail in the final C&R Plan for the Project (Connacher 2010, Part E).

Connacher will develop appropriate vegetation and wetland monitoring programs in consultation with provincial regulators and regional stakeholders once the Project has been approved. These programs will allow for adaptive management strategies to be incorporated. Connacher will work cooperatively with government, industry and stakeholders on an integrated land management strategy including the development of old growth forests. Reclamation monitoring and further measures, as needed, will be ongoing until the reclamation criteria of the day are met.

7.1 Terrestrial Vegetation

7.1.1 Mitigation

- developing revegetation plans that will promote the long term establishment of healthy ecosystems and ingress of native species;
- preserving adjacent habitat by minimizing the area required for construction and operation of the Project;
- stockpiled topsoil should be seeded with suitable species mix to ensure long term stability of the piles reducing erosion and the potential for weed establishment;
- when available, coarse woody debris should be used to amend soils to provide mycorrhizal and microbial inoculum;
- re-vegetation will be conducted according to the reclamation guidelines prepared by the Oil Sands Vegetation Reclamation Committee (OSVRC, 1998), CEMA, or updates;
- reporting the findings of rare and unranked species to ANHIC for updating provincial All Element Lists;
- placing rare species voucher specimens in a herbarium;
- merchantable timber will be salvaged;
- select areas will be planted with pine and white and black spruce seedlings 2 to 4 years after seeding reclaimed lands; and
- where possible, planting of aspen and white spruce should be used to increase the diversity of ecosite phases, versus the standard planting of mainly pine.

7.1.2 Monitoring

- monitor reclaimed sites to assess the development of healthy ecosystems that will support natural vegetation capable of ecological succession;
- monitor timber harvesting activities to ensure all merchantable timber is salvaged;
- performing survival, growth and health assessments to monitor the success of revegetation efforts; and

- conducting a rare plant survey on any new development areas not included in this assessment.

7.2 Wetlands

7.2.1 Mitigation

- accepted construction and reclamation practices should be used to maintain drainage patterns and preserve the integrity of wetland areas outside the Project footprint;
- culverts should placed within wetlands that will be divided by roads to ensure that water flow to wetlands outside of the PF will not be affected;
- Create wetland “transition areas” between reclaimed sites and natural uplands and wetlands;
- Remove fill material placed over organics to reestablish wetlands;
- Reclaim borrow areas to wetlands, where possible; and,
- utilize opportunities to direct place peat materials from peatland areas scheduled for development to provide a living peat substrate and a propagule source for wetland vegetation.

7.2.2 Monitoring

- monitoring and maintenance of drainage control structures should be conducted regularly to ensure water flow and flow patterns are maintained in wetlands adjacent to the PF during the construction, operation, and closure phases of the Project;
- roads removed at Project closure which may have had an effect on adjacent wetlands should be monitored to ensure restoration of water flow; and
- monitoring of reclaimed wetlands should continue after closure to ensure healthy wetlands are being created.

7.3 Old Growth Forests

7.3.1 Mitigation

- select areas should be planted with pine and white spruce;
- mixed species should be planted, including some aspen, particularly if post-reclamation observations do not detect natural aspen ingress from adjacent habitat or establishment from replaced stockpiled topsoil; and

- where suitable, introducing woody species typical of b1, b2, c1, d1, and g1 ecosite phases;

7.3.2 Monitoring

- performing survival, growth and health assessments to monitor the success of revegetation efforts

7.4 Non-native and Invasive Species

7.4.1 Mitigation

- minimize areas of bare ground during Project construction and operation;
- use a non-invasive seed-mix for erosion control, and use approved revegetation species that are compatible with the intended end land use;
- implement a weed control program during construction, operations and reclamation;
- equipment arriving from offsite should be cleaned to remove dirt and vegetative material before accessing the PF; and
- during reclamation use recommended techniques and species that will limit the establishment and spread of non-native and invasive species (AENV 2008; OSVRC 1998);

7.4.2 Monitoring

- ensure regular site inspections during the life of the Project (construction, operation and closure) to identify if invasive species are becoming established;
- control any weed populations that are identified during monitoring; and
- assess the success of weed control activities.

7.5 Traditionally Used Plants

7.5.1 Mitigation

- Aboriginal communities should be invited to participate in mitigation and monitoring recommendations and implementation to lend TEK that will compliment reclamation efforts; and
- Connacher should determine alternative sources of traditionally used plants.

7.5.2 Monitoring

- follow-up with Aboriginal communities as recommended during the consultation process.

7.6 Biodiversity

7.6.1 Mitigation

- areas with high biodiversity should be identified and the surface soil should be considered for soil salvage and use in direct placement reclamation;
- an adaptive reclamation strategy should be implemented to take advantage of opportunities present on the post-development contoured lands for establishment of a variety of plant communities (ecosite phases);
- use native shrubs (willow, berry species) and deciduous trees (aspen) where possible to provide structural diversity to the reclaimed stands as well as browse for wildlife; and
- in areas where there is poor survival of seedlings, fill planting should be performed if target stocking densities are in jeopardy.

7.6.2 Monitoring

- regeneration surveys should be utilized to monitor for health and survival of planted trees; and
- post reclamation surveys should be completed on sites reclaimed early in the life of the Project to assess success and allow for adaptive management of subsequent stages of reclamation.

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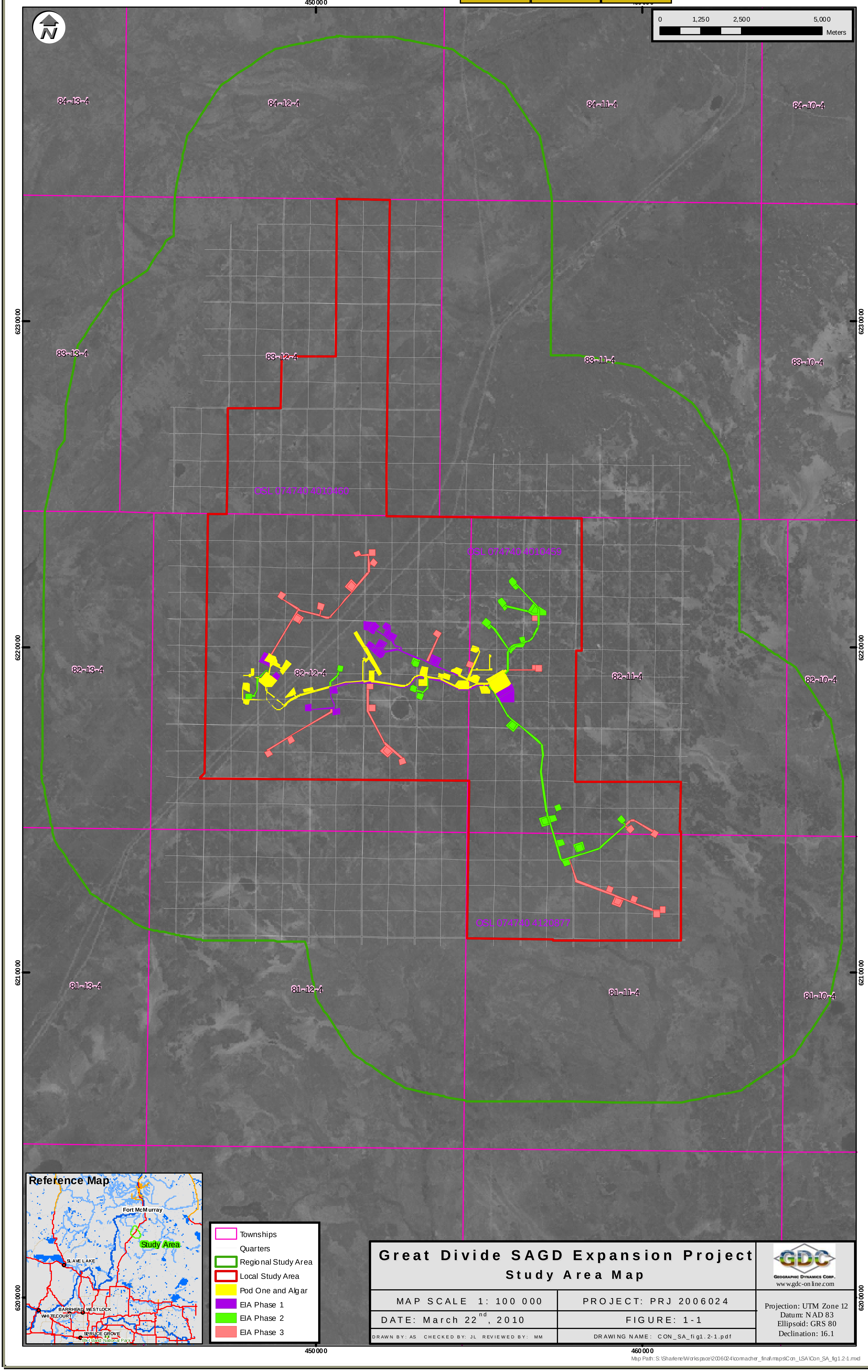
450000
460000
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1,250
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Meters
84-13-4
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81-13-4
81-12-4
81-11-4
81-10-4
OSL 074740 4010460
OSL 074740 4010459
OSL 074740 4120877
Reference Map
Fort McMurray
Study Area
SLAVE LAKE
BARRHEAD
WESTLOCK
WHITECOURT
SPRUCE GROVE
Townships
Quarters
Regional Study Area
Local Study Area
Pod One and Algar
EIA Phase 1
EIA Phase 2
EIA Phase 3
Great Divide SAGD Expansion Project
Study Area Map
GDC
GEOGRAPHIC DYNAMICS CORP.
www.gdc-online.com
MAP SCALE 1: 100 000
PROJECT: PRJ 2006024
DATE: March 22nd, 2010
FIGURE: 1-1
DRAWN BY: AS CHECKED BY: JL REVIEWED BY: MM
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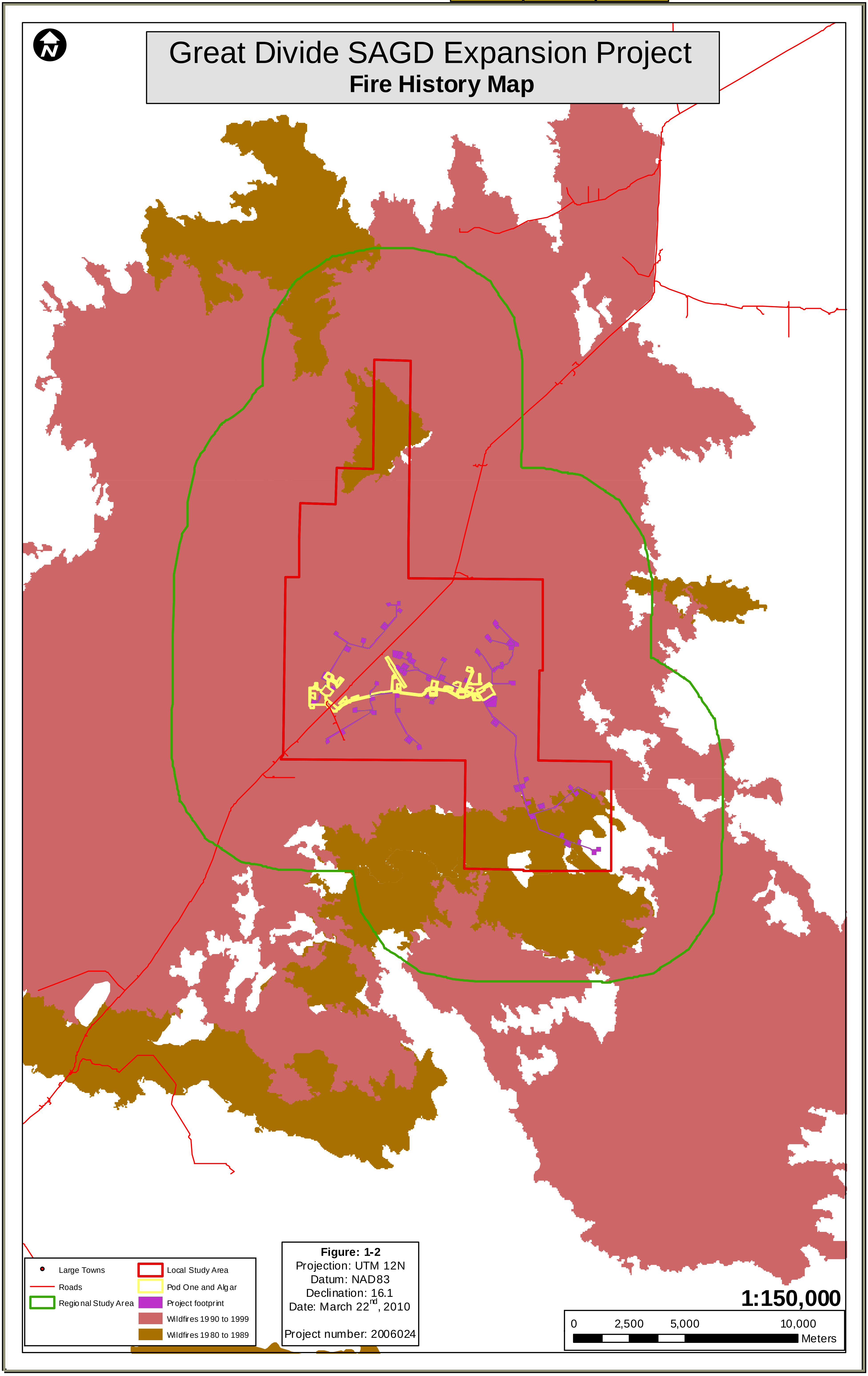
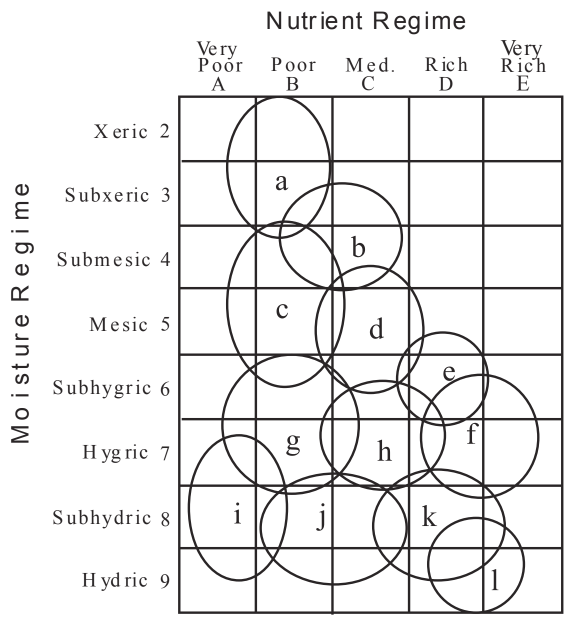
Projection: UTM Zone 12
Datum: NAD 83
Ellipsoid: GRS 80
Declination: 16.1



Great Divide SAGD Expansion Project
Fire History Map
Large Towns
Roads
Regional Study Area
Local Study Area
Pod One and Algar
Project footprint
Wildfires 1990 to 1999
Wildfires 1980 to 1989
Figure: 1-2
Projection: UTM 12N
Datum: NAD83
Declination: 16.1
Date: March 22nd, 2010
Project number: 2006024
1:150,000
0
2,500
5,000
10,000
Meters



Ecosites:

a = lichen
subxeric/poor

b = blueberry
submesic/medium

c = Labrador tea–mesic
mesic/poor

d = low-bush cranberry
mesic/medium

e = dogwood
subhygric/rich

f = horsetail
hygric/rich

g = Labrador tea–subhygric
subhygric/poor

h = Labrador tea/horsetail
hygric/medium

i = bog
subhydric/very poor

j = poor fen
subhydric/medium

k = rich fen
subhydric/rich

l = marsh
hydric/rich

Figure 3-1. Edatope (moisture/nutrient grid) showing the location of ecosites for the Boreal Mixedwood ecological area (Beckingham and Archibald 1996).

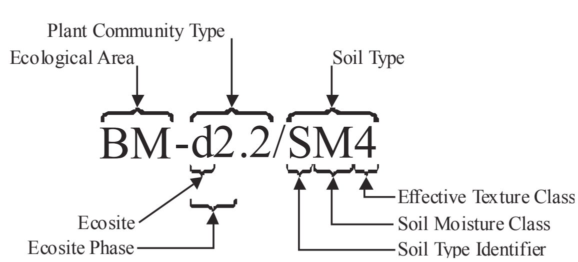
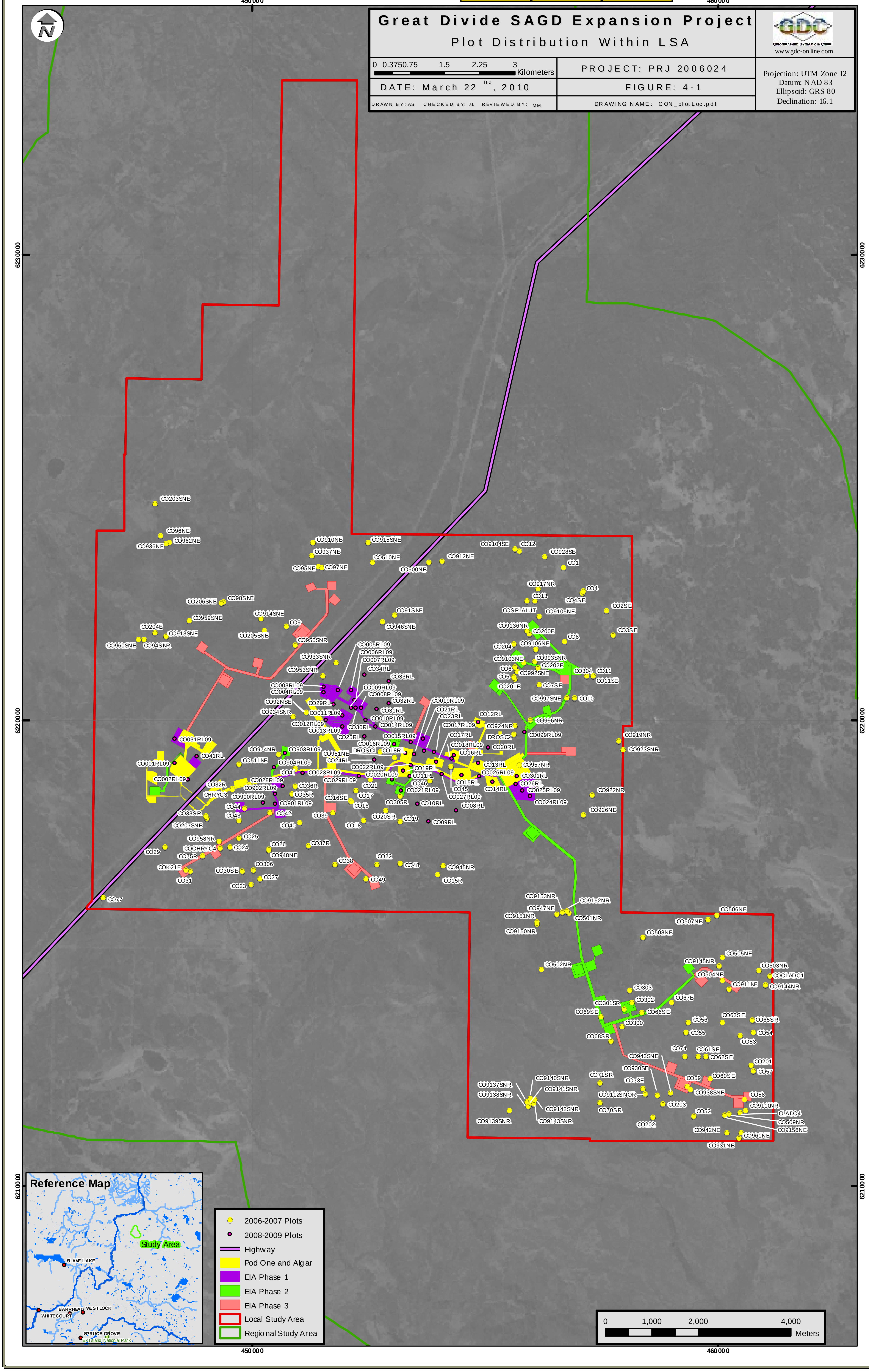


Figure 3-2. Example of an ecological unit identification code for the hierarchical ecological classification system (Beckingham and Archibald 1996).



Great Divide SAGD Expansion Project
Plot Distribution Within LSA
GDC
www.gdc-online.com
0 0.375 0.75 1.5 2.25 3 Kilometers
PROJECT: PRJ 2006024
DATE: March 22nd, 2010
FIGURE: 4-1
DRAWN BY: AS CHECKED BY: JL REVIEWED BY: MM
DRAWING NAME: CON_plotLoc.pdf
Projection: UTM Zone 12
Datum: NAD 83
Ellipsoid: GRS 80
Declination: 16.1
450000
460000
6230000
6220000
6210000
Reference Map
Study Area
SLAVE LAKE
BARRHEAD
WESTLOCK
WHITECOURT
SPRUCE GROVE
2006-2007 Plots
2008-2009 Plots
Highway
Pod One and Algar
EIA Phase 1
EIA Phase 2
EIA Phase 3
Local Study Area
Regional Study Area
0 1,000 2,000 4,000 Meters

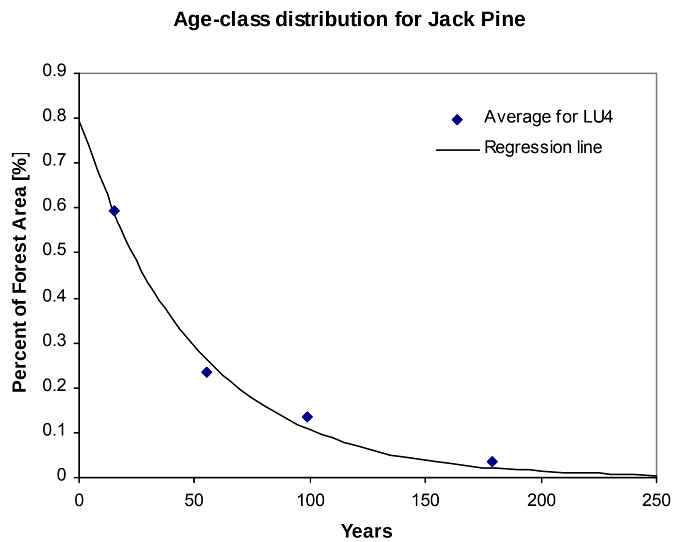


Figure 4-2. Age-class distribution for Jack pine with a 49.8 years fire rotation shown as a proportion of the entire forested area of LU 4.

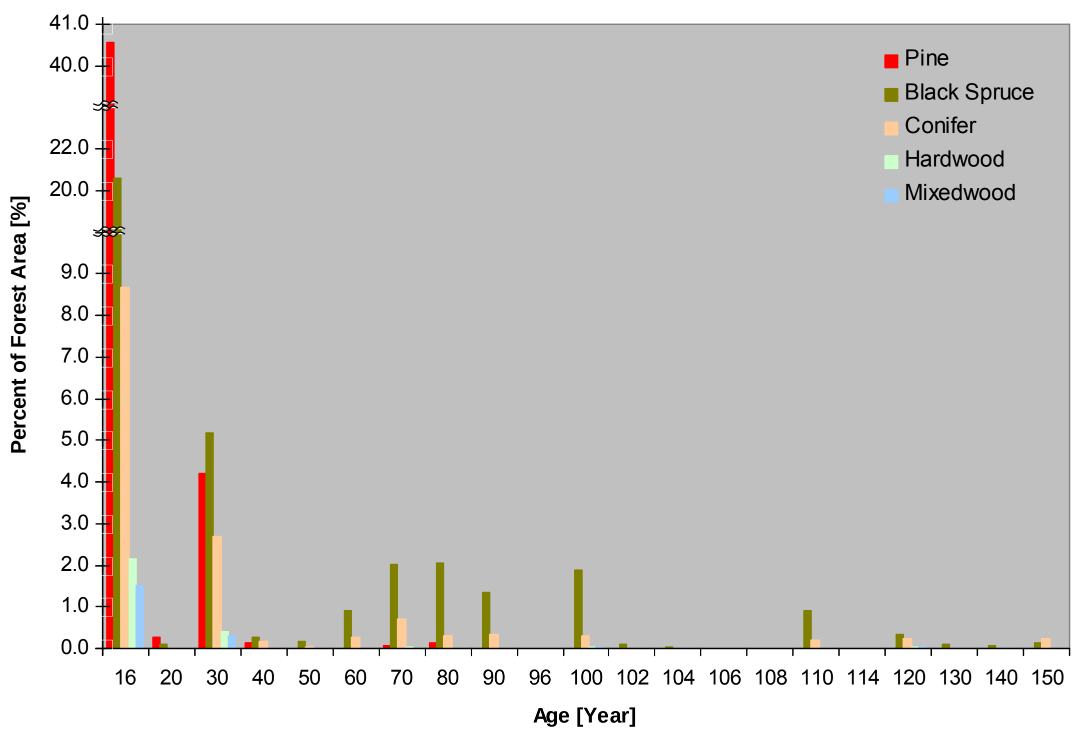
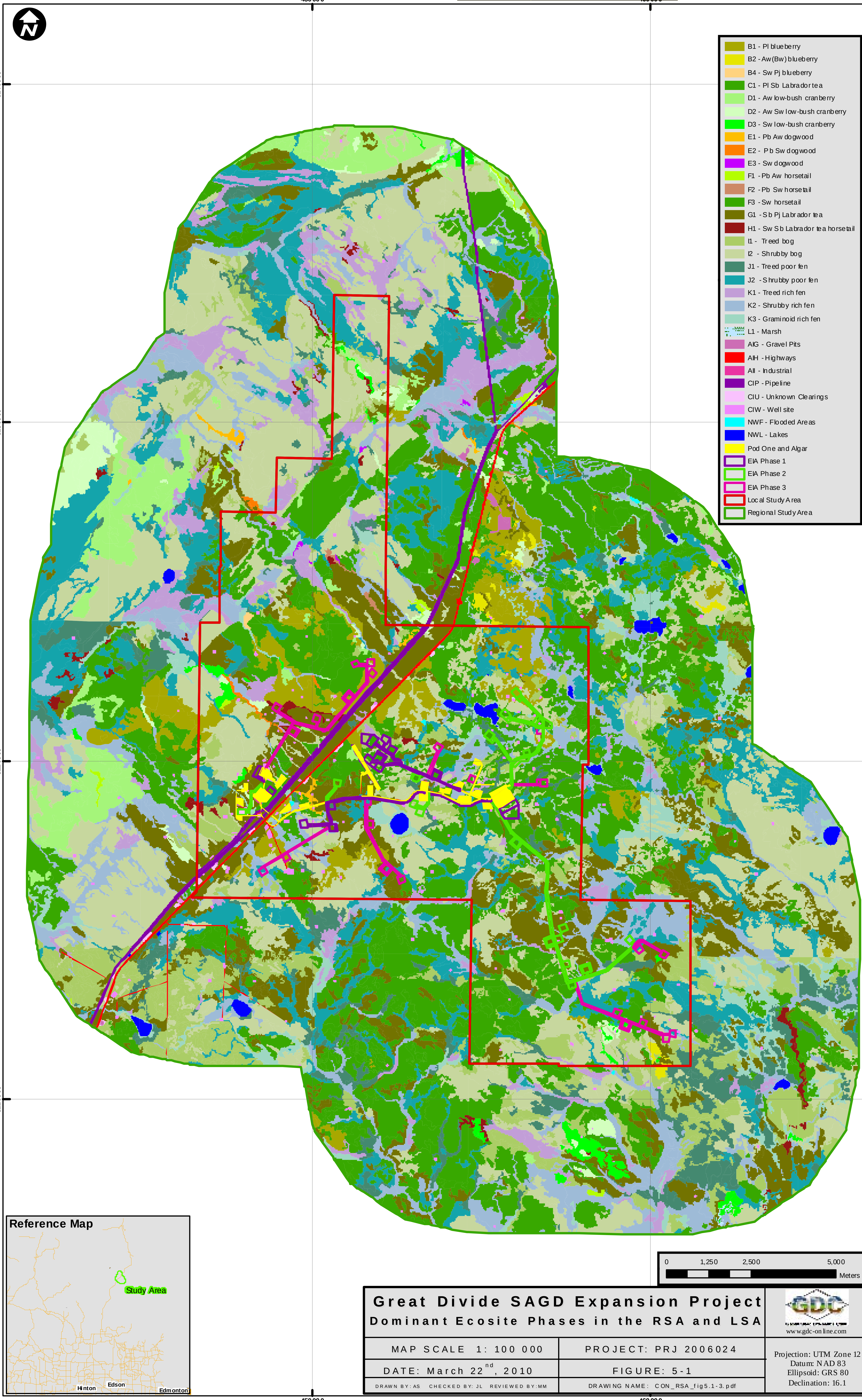
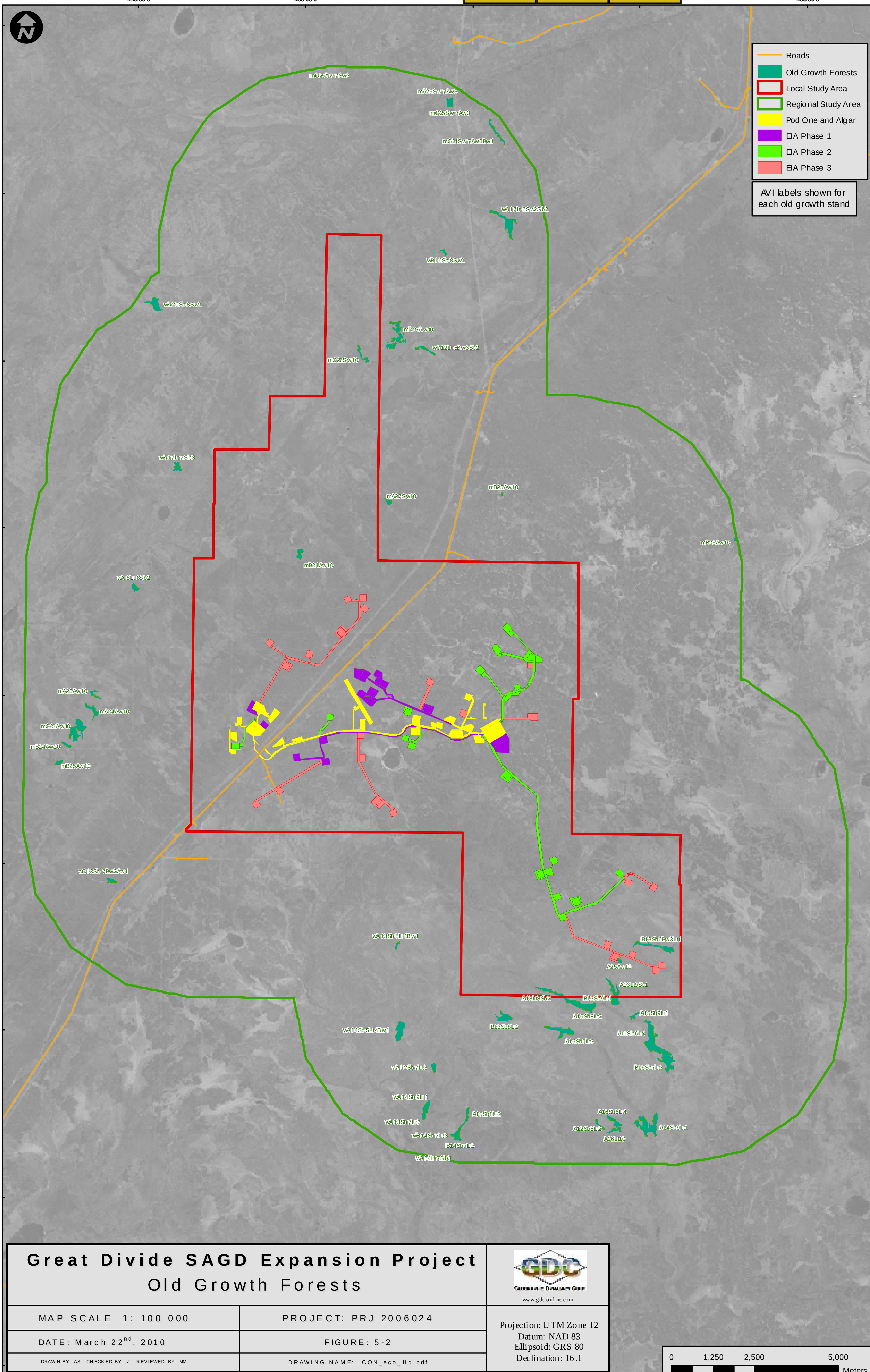


Figure 5-3. Proportion of Forest Types by Age (2-year Intervals) within the RSA



B1 - Pl blueberry
B2 - Aw(Bw) blueberry
B4 - Sw Pj blueberry
C1 - Pl Sb Labrador tea
D1 - Aw low-bush cranberry
D2 - Aw Sw low-bush cranberry
D3 - Sw low-bush cranberry
E1 - Pb Aw dogwood
E2 - Pb Sw dogwood
E3 - Sw dogwood
F1 - Pb Aw horsetail
F2 - Pb Sw horsetail
F3 - Sw horsetail
G1 - Sb Pj Labrador tea
H1 - Sw Sb Labrador tea horsetail
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
L1 - Marsh
AIG - Gravel Pits
AIH - Highways
AII - Industrial
CIP - Pipeline
CIU - Unknown Clearings
CIW - Well site
NWF - Flooded Areas
NWL - Lakes
Pod One and Algar
EIA Phase 1
EIA Phase 2
EIA Phase 3
Local Study Area
Regional Study Area
450000
460000
6240000
6230000
6220000
6210000
Reference Map
Study Area
Hinton
Edson
Edmonton
0
1,250
2,500
5,000
Meters
Great Divide SAGD Expansion Project
Dominant Ecosite Phases in the RSA and LSA
www.gdc-online.com
MAP SCALE 1: 100 000
PROJECT: PRJ 2006024
DATE: March 22nd, 2010
FIGURE: 5-1
DRAWN BY: AS CHECKED BY: JL REVIEWED BY:MM
DRAWING NAME: CON_RSA_fig5.1-3.pdf
Projection: UTM Zone 12
Datum: NAD 83
Ellipsoid: GRS 80
Declination: 16.1

Main Menu | Search | Main TOC



Great Divide SAGD Expansion Project

Old Growth Forests

MAP SCALE 1: 100 000	PROJECT: PRJ 2006024
DATE: March 22nd, 2010	FIGURE: 5-2
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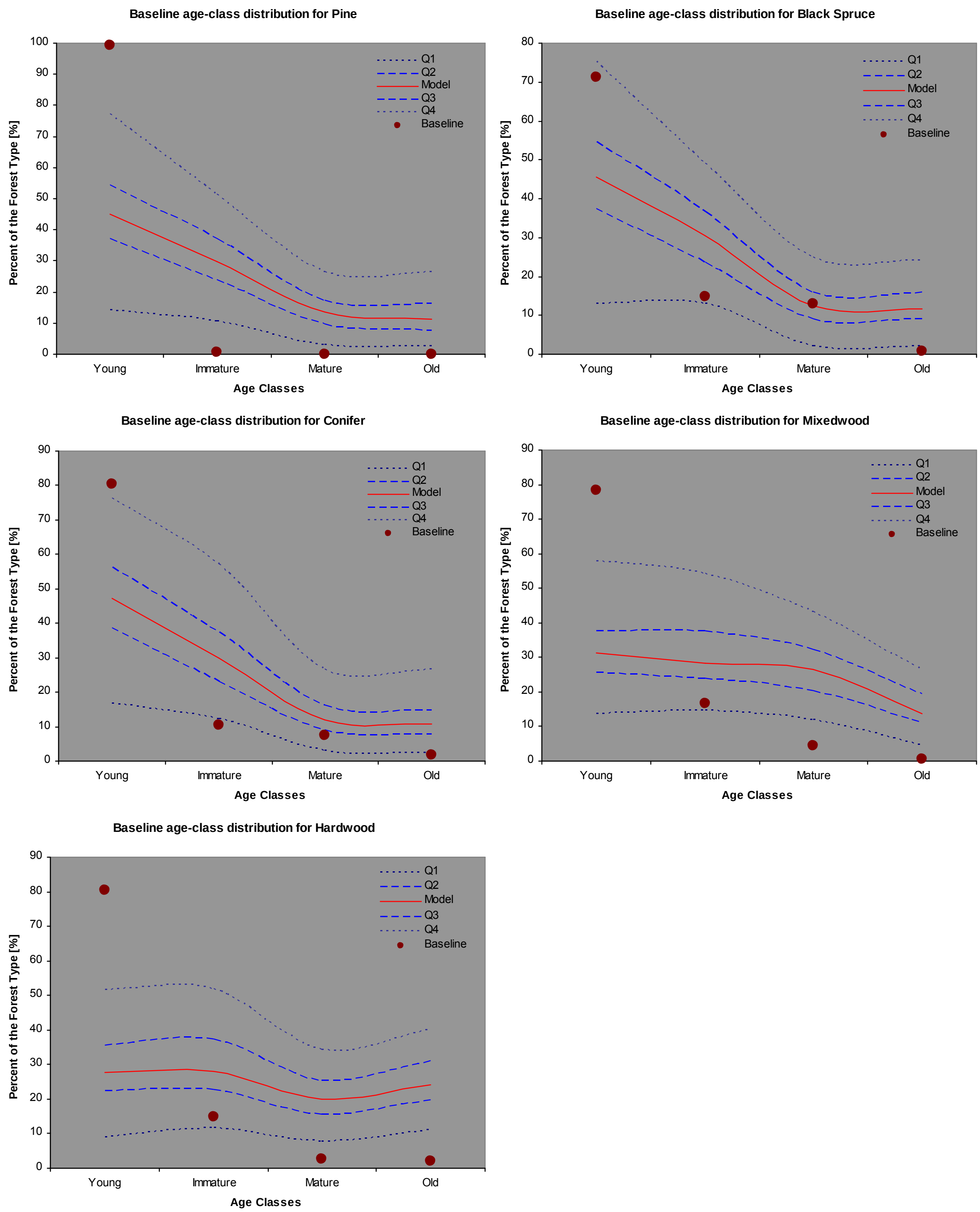
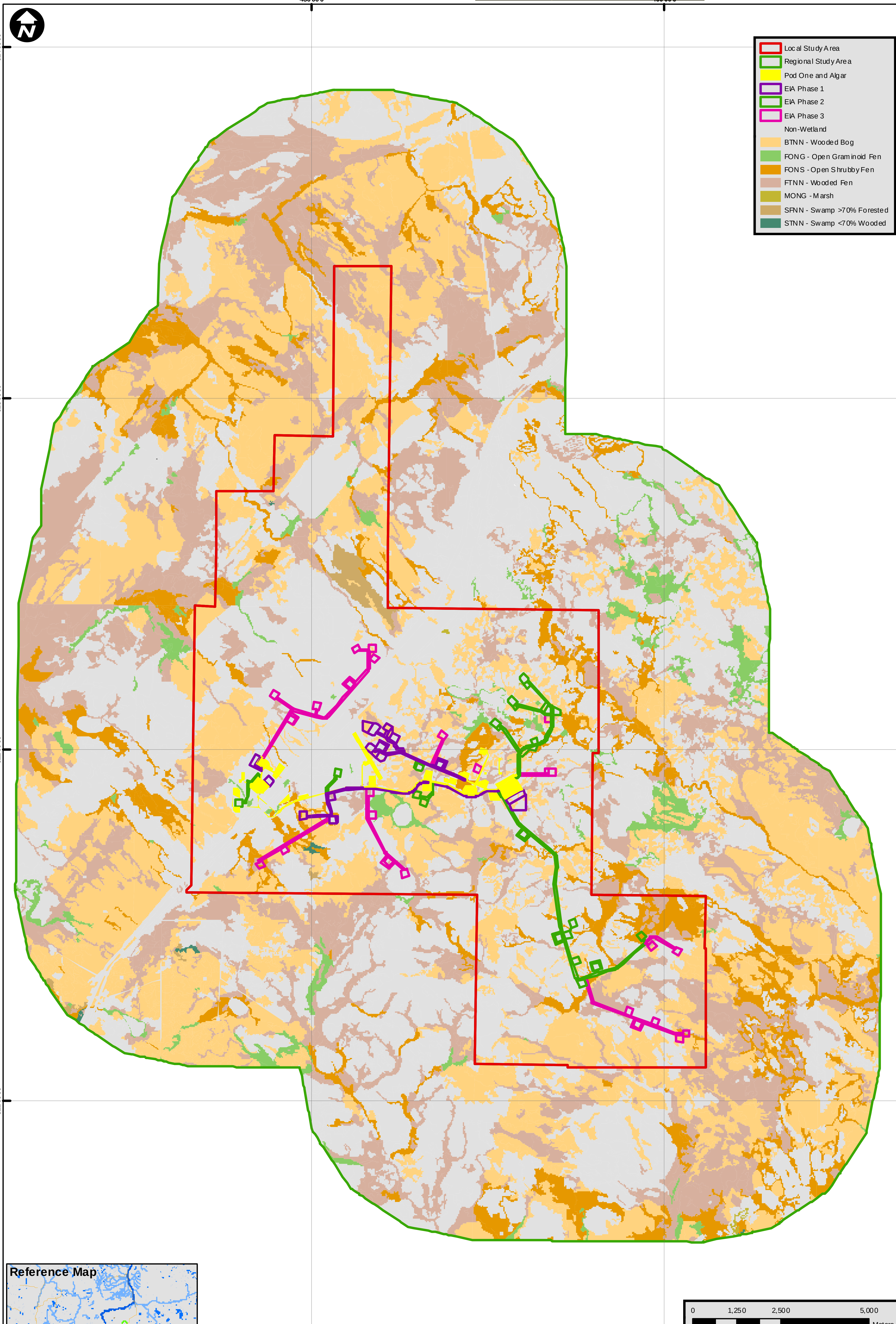


Figure 5-4. Baseline Age-Class Distributions by Forest Type in RSA. Shown is the current condition (baseline) relative to the expected distribution for each forest type. The natural range of variation for Landscape Unit 4 is shown as quartiles.

Main Menu | Search | Main TOC



Great Divide SAGD Expansion Project

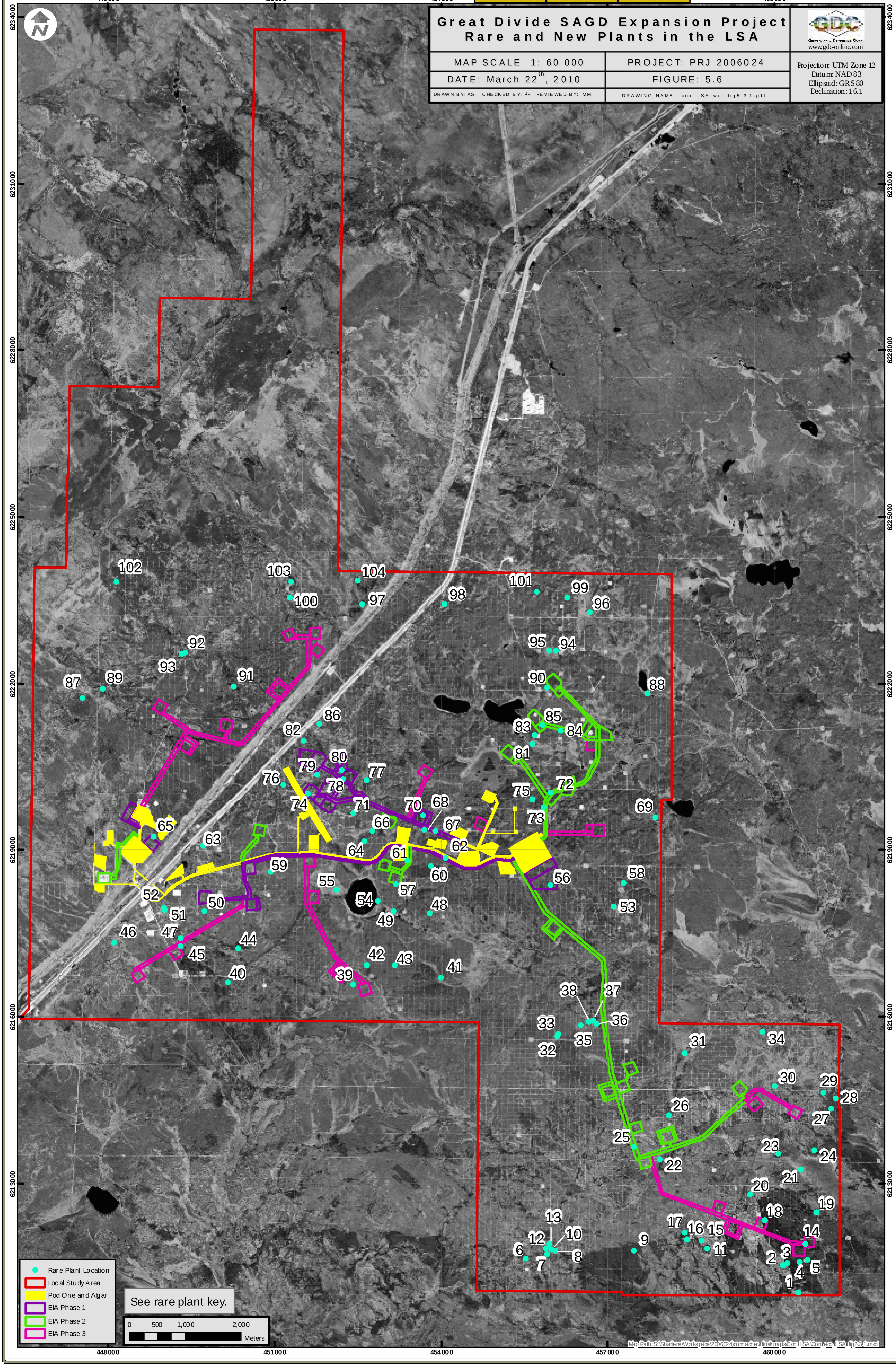
Dominant Wetlands in the RSA and LSA

MAP SCALE 1: 100 000	PROJECT: PRJ 2006024
DATE: March 22nd, 2010	FIGURE: 5-5
DRAWN BY: AS CHECKED BY: JL REVIEWED BY: MM	DRAWING NAME: con_rsa_wet_fig3.3-2.pdf

www.gdc-online.com

Projection: UTM Zone 12
Datum: NAD 83
Ellipsoid: GRS 80
Declination: 16.1

Main Menu | Search | Main TOC



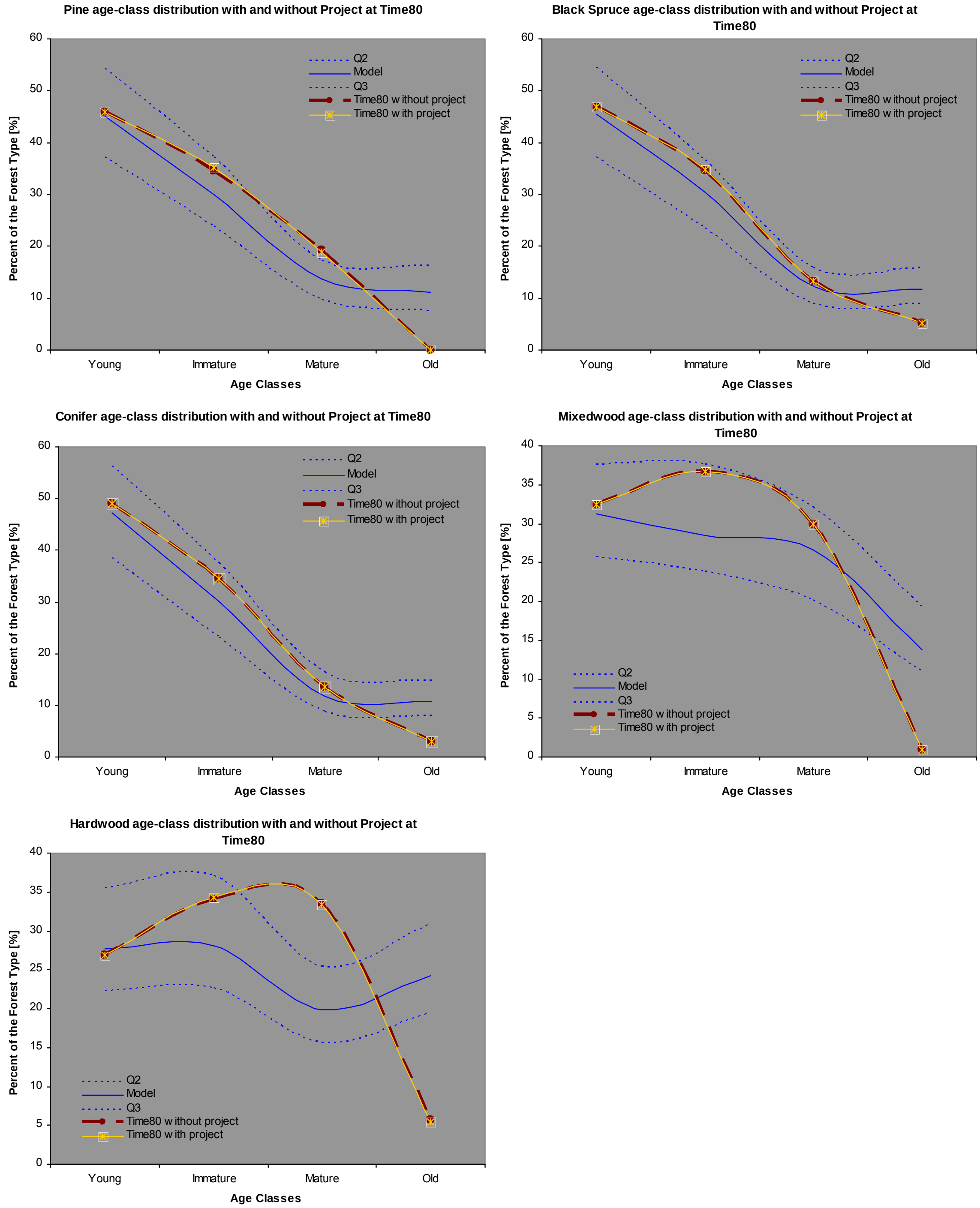


Figure 6-1. Predicted Age-Class Distributions by Forest Type in RSA at Time80.

Appendix 1 – Final Terms of Reference – Concordance Table

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
1.0	**PUBLIC ENGAGEMENT AND ABORIGINAL CONSULTATION**		
2.6	• **LAND MANAGEMENT**		
[B]	• Provide a timber salvage plan, highlighting end users and identifying proposed volumes for removal (by species and year) for all stages of the Project.		Veg 5.1.1.6
2.10	• **CONSERVATION AND RECLAMATION**		
[A]	• Provide a conceptual conservation and reclamation plan for the Project considering:		
	b) existing information with respect to land capability, vegetation, commercial forest land base by commercialism class, forest productivity, recreation, wildlife, aquatic resources, aesthetics and land use resources;		Veg 5.1; 5.1.1.6
	f) post-development land capability with respect to: i. self-sustaining topography, drainage and surface watercourses representative of the surrounding area, ii. existing traditional use with consideration for traditional vegetation and wildlife species in the reclaimed landscape, iii. wetlands, iv. self-sustaining vegetation communities representative of the surrounding area, and v. reforestation and forest productivity;		Veg 5.1.1.8; 5.2; 6.2.2; 6.2.5
[B]	• Provide a predicted Ecological Land Classification (ELC) map for the post-reclamation landscape considering potential land uses, including traditional uses and how the landscape and soils have been designed to accommodate future land use.		Veg 6.2.1
[C]	• Provide a conceptual plan to monitor reclamation performance success (including soils, vegetation, wildlife and aquatic resources).		Veg 7.0
2.12	**Regional and Cooperative Initiatives**		
[A]	• Discuss Connacher's involvement in regional and cooperative efforts to address environmental and socio-economic issues associated with regional development, including:		

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
	a) potential cooperative ventures that Connacher has initiated, could initiate or could develop with other operators and other resource users;		Veg 7.0
3.0	**ENVIRONMENTAL ASSESSMENT**		
3.1	**Assessment Requirements**		
3.1.1	**Scenarios**		
[A]	• Define assessment scenarios including:		Veg. 3.1.1
	a) a Baseline Case, which includes existing environmental conditions, existing and approved projects or activities;		Veg. 2.2.3.1
	b) an Application Case, which includes the Baseline Case with the effects of the Project added; and		Veg. 2.2.3.2
	c) a Planned Development Case, which includes past, existing and anticipated future environmental conditions, based on existing and approved projects or activities plus planned projects or activities reasonably expected to occur.		Veg 2.2.3.3
3.1.2	**Study Areas**		
3.1.2.1	**Project Area**		
[A]	• The Project Area includes all lands subject to direct disturbance from the Project and associated infrastructure. For the Project Area provide:		
	a) the legal land description;		Veg. 1.2.2; 1.2.3; 1.2.4
	e) a topographic map of appropriate scale showing the area proposed to be disturbed in relation to existing township grids, wetlands, watercourses, and waterbodies.		Veg Fig. 1-1; 5-1; 5-3; 5-6; 5-7
3.1.2.2	**Local and Regional Study Areas**		
[A]	• The Local Study Area (LSA) is the area existing outside the boundaries of the Project Area, where there is a reasonable potential for immediate environmental impacts due to ongoing Project activities.		Veg 1.2.3
[B]	• The Regional Study Area (RSA) is the area within which there is the potential for cumulative and socio-economic effects, and that may be relevant to the assessment of any wider-spread effects of the Project.		Veg. 1.2.4

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
[C]	• The Study Area for the EIA report shall include the Project Area as well as, the spatial and temporal limits of individual environmental components outside the Project Area boundaries where an effect can be reasonably expected. The Study Area includes both the Local and Regional Study Areas.		Veg. 1.2.1; 1.2.2; 1.2.3; 1.2.4; 2.2.1; 2.2.2
[D]	• For each LSA and RSA:		
	a) provide the scientific rationale used to define the spatial and temporal aspects considering the location and range of probable Project and cumulative effects; and		Veg. 1.2.3;1.2.4; 2.2.1; 2.2.2
	b) identify LSA and RSA boundaries on maps of appropriate scale that show existing township grids, communities, wetlands, watercourses, waterbodies, protected areas and other topographic features.		Veg. Fig. 1-1; 5-1; 5-3; 5-6; 5-7
3.1.3	**Cumulative Effects Assessment**		
[A]	• Connacher will assess cumulative environmental effects in accordance with the ERCB/AENV/Natural Resources Conservation Board Information Letter, *Cumulative Effects Assessment in Environmental Impact Assessment Reports under the Alberta Environmental Protection and Enhancement Act* June 2000. Connacher will include a summary of all proposed monitoring, research and other strategies or plans to minimize, mitigate and manage any potential adverse effects.		Veg 7.0
[B]	• Explain the approach and methods used to identify and assess cumulative impacts, including cooperative opportunities and initiatives undertaken to further the collective understanding of cumulative effects. Provide a record of relevant assumptions, confidence in data and analysis to support conclusions.		Veg. 4.0; 5.0; 6.0
3.1.4	**Information Requirements**		
[A]	• Connacher will include the following environmental information for each assessment scenario:		
	a) a description of and rationale for the selection of environmental attributes, parameters, or properties examined;		Veg 2.1
	b) for each selected environmental attribute, parameter, or		Veg I) 4.0; 5.0;

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
	property: i. describe existing conditions. Comment on whether the available data are sufficient to assess impacts and mitigative measures. Identify environmental disturbance from previous, current, and approved activities that have become part of the baseline conditions, ii. describe the environmental effects associated with the development activities, iii. provide plans to minimize, mitigate or eliminate negative effects and impacts. Discuss the key elements of such plans, iv. provide a description of the process and criteria used to determine the significance of environmental effects, v. provide a plan to manage environmental changes and identify any follow-up programs necessary to verify the accuracy of the environmental assessment and to determine effectiveness of measures taken to mitigate adverse environmental effects; and vi. describe residual effects and their significance;		5.1 ii) 5.1; 6.2 iii) 6.2, 7.0 iv) 2.2.3 v)2.2.3; 7.0 vi) 6.2
	c) a discussion of the sources of information used in the assessment including: i. a summary of previously conducted environmental assessments related to Connacher's operations, ii. literature, previous EIA reports and environmental studies; operating experience from current, similar operations; industry study groups; traditional knowledge; and government sources, and iii. limitations or deficiencies that the information may place on the analysis or conclusions in the EIA report. Discuss how these limitations or deficiencies may be addressed within the EIA report; and		Veg. i)3.1.3; 3.2.3; 3.3.3; 3.4.3 ii) 3.1.3; 3.2.3; 3.3.3; 3.4.3 iii) 4.1.5
	d) a description of the techniques used to identify and evaluate the environmental impacts and effects resulting from the Project.		Veg 2.1;2.2.4; 6.2
[B]	• The EIA report shall:		
	a) identify where deficiencies in information exist and describe Connacher's plan, including a rationale, for providing the necessary information. Where required, undertake studies and investigations to obtain additional information to address the information deficiencies;		Veg 4.0

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
	b) provide a sufficient base for the prediction of positive and negative impacts and the extent to which negative impacts may be mitigated by planning, project design, construction techniques, operational practices and reclamation techniques. Impact significance will be quantified where possible and assessed including consideration of spatial, temporal and cumulative aspects;		Veg 6.2
	c) provide a plan that addresses the adverse impacts associated with the Project that may require joint resolution by government, industry and the community. Describe how this plan might be implemented and how it would incorporate the participation of government, industry and the community; and		Veg 7.0
	d) present biophysical information in a manner that enables ecological land classification maps to be completed to the ecosite classification level.		Veg 4.1; 5.1; Fig 5-1; 5-3
3.1.5	**Modeling**		
[A]	• For those models or modeling techniques used that are not prescribed by regulators to predict Project impacts provide:		
	a) the justification for the model used;		Veg 4.1; 4.4
	b) documentation of the assumptions and data sets used to obtain the modeling predictions in the EIA report; and		Veg 4.1; 4.4
	c) a discussion of the limitations of the models, including sources of error and relative accuracy, and how these limitations were addressed in the EIA report.		Veg 4.1; 4.4
[B]	• Air quality modeling should be conducted in accordance with the latest edition of the *Air Quality Modeling Guidelines* published by Alberta Environment.		
3.2	**Air Quality, Climate and Noise**		
3.2.2	**Impact Assessment**		
[A]	• Identify components of the Project that will affect air quality, and:		
	f) describe air quality impacts resulting from the Project, and their implications for other environmental resources, including habitat diversity and quantity, soil resources, vegetation resources, and water quality.		Veg 5.1.2.6; 6.2.1.4
3.7	**VEGETATION**		

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
3.7.1	**Baseline Information**		
[A]	• Describe and map the vegetation communities for each ecosite phase.		5.1; Appendix 3; Figure 5-1
[B]	• Describe and map wetlands, and discuss their distribution and relative abundance.		5.2; Appendix 6; Figure 5-5
[C]	• Identify, verify and map the relative abundance of species of rare plants and the ecosite phases where they are found.		5.3.2; Figure 5-6
[D]	• Identify key indicators and discuss the rationale for their selection. Identify composition, distribution, relative abundance, and habitat requirements. Address those species listed as "at Risk, May be at Risk and Sensitive" in *The Status of Alberta Species* (Alberta Sustainable Resource Development) and all species listed in Schedule 1 of the federal *Species at Risk Act*.		2.1; 5.1; 5.2; 5.3; 5.4
[E]	Discuss the potential of each ecosite phase to support rare plant species, plants for traditional, medicinal and cultural purposes, old growth forests and communities of limited distribution. Consider their importance for local and regional habitat, sustained forest growth, rare plant habitat and the hydrologic regime.		5.1; 5.1.3; 5.2; 5.2.3; 5.3; 5.3.3
[F]	• Describe the regional relevance of landscape units that are identified as rare.		6.2.1; 6.2.2
[G]	• Provide Timber Productivity Ratings for both the Project Area and the LSA, including identification of productive forested, non-productive forested and non-forested lands.		5.1.2.3
3.7.2	**Impact Assessment**		
[A]	• Identify the amount of vegetation and wetlands to be disturbed for all stages of the Project.		5.1.3; 5.2.3; 6.2.1; 6.2.2
[B]	• Discuss any potential effects the Project may have on rare plants or endangered species, in The Status of Alberta Species (Alberta Sustainable Resource Development) and the Alberta Natural Heritage Information Centre (ANHIC).		5.3.4; 6.2.1.2
[C]	• Discuss temporary (include timeframe) and permanent changes to vegetation and wetland communities and comment on:		
	a) the effects and their implications for other environmental		6.2

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
	resources (e.g., habitat diversity and quantity, water quality and quantity, erosion potential, recreation and other uses);		
	b) the effects and their implications to recreation, aboriginal and other uses; and		6.2
	c) the sensitivity to disturbance (including acid deposition), as well as the techniques used to estimate sensitivity to disturbance and reclamation, of each vegetation community.		6.2
[D]	Describe the regional impact of any ecosite phase to be removed.		6.2.1.1
[E]	Discuss from an ecological perspective, the expected timelines for establishment and recovery of vegetative communities and the expected differences in the resulting vegetative community structures.		6.2.1.5
[F]	Provide an ELC map that shows the reclaimed vegetation. Comment on the importance of the size, distribution and variety of the reclaimed landscape units from both a local and regional perspective.		6.2.1.5; 6.2.6
[G]	Discuss the impact of any loss of wetlands, as well as how this will affect land use, fragmentation and biodiversity. Discuss measures and techniques that will be used to minimize the impact.		6.2.2; 6.2.6
[H]	Provide a mitigation strategy that will minimize Project impacts addressing:		
	a) mitigation of the adverse effects of site clearing on rare plants, plant communities and plants for traditional, medicinal and cultural purposes. Identify any setbacks proposed around environmentally-sensitive areas such as surface waterbodies, riparian areas and wetlands; and		7.1; 7.5
	b) measures and techniques that will be used to minimize the impact of loss of wetlands on land use, fragmentation and biodiversity.		6.2.2; 6.2.6; 7.2; 7.6
[I]	Discuss weeds and non-native invasive species and describe how these species will be assessed and controlled prior to and during operation and reclamation.		5.1.1.5; 6.2.3; 7.4
[J]	Describe the residual effects of the Project on vegetation and Connacher's plans to manage those effects.		6.2; 7.0
3.7.3	**MONITORING**		
[A]	Describe the monitoring programs that proposed to assess Project impacts to vegetation, wetlands and riparian habitat and to measure the effectiveness of mitigation measures.		7.0

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
3.9	**Biodiversity and Fragmentation**		
3.9.1	**Baseline Information**		
[A]	• Describe the terrestrial and aquatic biodiversity metrics that will be used to characterize the existing ecosystems and probable effects on the Project, and:		Veg 3.4.1; 4.4
	a) describe the process and rationale used to select biotic and abiotic indicators for biodiversity within selected taxonomic groups;		Veg 4.4
	b) determine the relative abundance of species in each ecosite phase;		Veg 5.4; 6.2.6
	c) provide species locations, lists and summaries of observed and estimated species richness and evenness for each ecosite phase;		Veg 5.4; Appendix 2 and 8
	d) provide a measure of biodiversity on baseline sites that are representative of the proposed reclamation ecosites; and		Veg 5.4
	e) rank each ecological unit for biodiversity potential. Describe the techniques used in the ranking process.		Veg 4.4; 5.4
[B]	• Describe the current level of habitat fragmentation.		Veg 5.4; 6.2
3.9.2	**Impact Assessment**		
[A]	• Describe the metrics that will be used to assess the probable effects of the Project. Discuss the contribution of the Project to any anticipated changes in regional biodiversity and the potential impact to local and regional ecosystems.		Veg 4.4; 5.4; 6.2.6
[B]	• Identify and evaluate the extent of potential effects from fragmentation that may result from the Project.		Veg 6.2.6
[C]	• Discuss the measures to minimize any anticipated changes in regional biodiversity.		Veg 7.6
[D]	• Describe the residual effects of the Project on biodiversity and fragmentation and Connacher's plans to manage those effects.		Veg 6.2.6
3.9.3	**Monitoring**		
[A]	• Describe the monitoring programs proposed to assess Project impacts on biodiversity and fragmentation and to measure the effectiveness of		Veg 7.6.2

TOR Section	Topic	Ref. Section in Application	Ref. Section in Supporting Documents
	mitigation plans.		
3.11	**Land Use**		
3.11.2	**Impact Assessment**		
[A]	• Identify the potential impact of the Project on land uses, including:		
	e) the impact of development and reclamation on commercial forest harvesting in the Project Area. Include opportunities for timber salvage, revegetation, reforestation and harvest for the reduction of fuel hazard;		Veg 5.1.1.6, Veg 6.2.1.3
	f) the amount of commercial and non-commercial forest land base that will be disturbed by the Project. Compare the pre-disturbance and reclaimed percentages and distribution of all forested communities in the Project Area;		Veg 5.1.1.6
	g)how the Project disturbance impacts Annual Allowable Cuts and quotas with the Forest Management Area;		Veg 6.2.1.3

Appendix 2 – Flora of the Great Divide SAGD Expansion Project

Strata	Scientific Name	Common name
Bryophyte	*Abietinella abietina*	wiry fern moss
Bryophyte	*Amblystegium serpens*	
Bryophyte	*Aulacomnium palustre*	tufted moss/glow moss
Bryophyte	*Blepharostoma trichophyllum*	liverwort
Bryophyte	*Brachythecium albicans*	
Bryophyte	*Brachythecium campestre*	
Bryophyte	*Brachythecium oedipum*	short-leaved ragged moss
Bryophyte	*Brachythecium rivulare*	waterside feather moss
Bryophyte	*Brachythecium salebrosum*	golden ragged moss
Bryophyte	*Brachythecium starkei*	
Bryophyte	*Brachythecium turgidum*	thick ragged moss
Bryophyte	*Brachythecium velutinum*	velvet feather moss
Bryophyte	*Bryum caespiticium*	(common weedy bryum)
Bryophyte	*Bryum lisae var. cuspidatum*	
Bryophyte	*Bryum pallescens*	
Bryophyte	*Bryum pseudotriquetrum*	tall clustered thread moss
Bryophyte	*Calliergon cordifolium*	heart-leaved feather moss
Bryophyte	*Calliergon giganteum*	giant water moss
Bryophyte	*Calliergon richardsonii*	Richardson's water moss
Bryophyte	*Calliergon stramineum*	straw-coloured water moss
Bryophyte	*Calypogeia sphagnicola*	liverwort
Bryophyte	*Campylium halleri*	
Bryophyte	*Campylium hispidulum*	
Bryophyte	*Campylium stellatum*	yellow star moss
Bryophyte	*Cephalozia bicuspidata*	liverwort
Bryophyte	*Cephalozia catenulata*	liverwort
Bryophyte	*Cephalozia connivens*	liverwort
Bryophyte	*Cephalozia lunulifolia*	liverwort
Bryophyte	*Cephalozia pleniceps*	liverwort
Bryophyte	*Cephaloziella hampeana*	liverwort
Bryophyte	*Cephaloziella rubella*	liverwort
Bryophyte	*Cephaloziella subdentata*	liverwort
Bryophyte	*Ceratodon purpureus*	purple horn-toothed moss/fire moss
Bryophyte	*Ceratophyllum demersum*	hornwort
Bryophyte	*Chiloscyphus pallescens*	liverwort
Bryophyte	*Cinclidium stygium*	common northen lantern moss
Bryophyte	*Climacium dendroides*	common tree moss
Bryophyte	*Conocephalum conicum*	snake liverwort
Bryophyte	*Cratoneuron filicinum*	(streamside) fern moss
Bryophyte	*Dicranella varia*	variable fork moss
Bryophyte	*Dicranum acutifolium*	cushion moss
Bryophyte	*Dicranum flagellare*	whip fork moss
Bryophyte	*Dicranum fragilifolium*	cushion moss

Strata	Scientific Name	Common name
Bryophyte	*Dicranum fuscescens*	curly heron's bill moss
Bryophyte	*Dicranum polysetum*	electric eels
Bryophyte	*Dicranum scoparium*	broom moss
Bryophyte	*Dicranum undulatum*	wavy dicranum
Bryophyte	*Ditrichum flexicaule*	slender-stemmed hair moss
Bryophyte	*Drepanocladus aduncus*	common hook moss
Bryophyte	*Eurhynchium pulchellum*	common beaked moss
Bryophyte	*Funaria hygrometrica*	cord moss
Bryophyte	*Hamatocaulis vernicosus*	stick hook moss
Bryophyte	*Helodium blandowii*	Blandow's feather moss
Bryophyte	*Hygroamblystegium tenax*	
Bryophyte	*Hygrohypnum luridum*	
Bryophyte	*Hylocomium splendens*	stair-step moss
Bryophyte	*Hypnum cupressiforme*	cypress pigtail moss
Bryophyte	*Hypnum lindbergii*	clay pigtail moss
Bryophyte	*Hypnum revolutum*	rolled-leaf pigtail moss
Bryophyte	*Hypnum vaucheri*	
Bryophyte	*Isopterygiopsis pulchella*	
Bryophyte	*Jamesoniella autumnalis*	Jameson's liverwort
Bryophyte	*Lepidozia reptans*	little hands liverwort
Bryophyte	*Leptobryum pyriforme*	Long-necked bryum
Bryophyte	*Leskeella nervosa*	
Bryophyte	*Limprichtia revolvens*	red hook moss
Bryophyte	*Lophozia excisa*	liverwort
Bryophyte	*Lophozia heterocolpos*	liverwort
Bryophyte	*Lophozia incisa*	liverwort
Bryophyte	*Lophozia ventricosa*	leafy liverwort
Bryophyte	*Marchantia polymorpha*	green-tongue liverwort
Bryophyte	*Mnium spinulosum*	red-mouthed mnium
Bryophyte	*Mylia anomala*	hard scale (common sphagnum) liverwort
Bryophyte	*Oncophorus virens*	green spur-fruited fork moss
Bryophyte	*Oncophorus wahlenbergii*	mountain curved-back moss
Bryophyte	*Orthotrichum affine*	
Bryophyte	*Orthotrichum obtusifolium*	blunt-leaved bristle moss
Bryophyte	*Orthotrichum speciosum*	showy bristle moss
Bryophyte	*Paludella squarrosa*	
Bryophyte	*Plagiochila asplenioides*	cedar-shake liverwort
Bryophyte	*Plagiomnium cuspidatum*	woodsy leafy moss
Bryophyte	*Plagiomnium drummondii*	Drummond's leafy moss
Bryophyte	*Plagiomnium ellipticum*	marsh magnificent moss
Bryophyte	*Plagiomnium medium*	common leafy moss
Bryophyte	*Plagiothecium denticulatum*	
Bryophyte	*Plagiothecium laetum*	
Bryophyte	*Platygyrium repens*	
Bryophyte	*Pleurozium schreberi*	big red stem/Schreber's moss
Bryophyte	*Pohlia cruda*	

Strata	Scientific Name	Common name
Bryophyte	*Pohlia nutans*	copper wire moss
Bryophyte	*Pohlia sphagnicola*	
Bryophyte	*Polytrichum commune*	common hair-cap
Bryophyte	*Polytrichum juniperinum*	juniper hair-cap
Bryophyte	*Polytrichum piliferum*	awned hair-cap
Bryophyte	*Polytrichum strictum*	slender hair-cap
Bryophyte	*Pseudobryum cinclidioides*	
Bryophyte	*Pseudocalliergon turgescens*	
Bryophyte	*Ptilidium pulcherrimum*	(small wood) naugehyde liverwort
Bryophyte	*Ptilium crista-castrensis*	knight’s plume moss
Bryophyte	*Pylaisiella polyantha*	stocking (aspen) moss
Bryophyte	*Rhizomnium gracile*	slender round moss
Bryophyte	*Rhizomnium pseudopunctatum*	felt round moss
Bryophyte	*Rhytidiadelphus triquetrus*	electrified cats-tail moss
Bryophyte	*Riccardia multifida*	liverwort
Bryophyte	*Saelania glaucescens*	glaucous hair moss
Bryophyte	*Sanionia uncinata*	sickle moss/hook moss
Bryophyte	*Sarmenthypnum sarmentosum*	
Bryophyte	*Scapania cuspiduligera*	liverwort
Bryophyte	*Scapania irrigua*	liverwort
Bryophyte	*Scorpidium scorpioides*	sausage moss
Bryophyte	*Sphagnum angustifolium*	poor fen peat moss
Bryophyte	*Sphagnum capillifolium*	acute-leaved peat moss
Bryophyte	*Sphagnum centrale*	peat moss
Bryophyte	*Sphagnum fuscum*	rusty peat moss
Bryophyte	*Sphagnum girgensohnii*	Girgensohn’s peat moss/common green sphagnum
Bryophyte	*Sphagnum jensenii*	pendant branch peat moss
Bryophyte	*Sphagnum magellanicum*	midway peat moss
Bryophyte	*Sphagnum riparium*	shore-growing peat moss
Bryophyte	*Sphagnum russowii*	wide-tongued peat moss
Bryophyte	*Sphagnum squarrosum*	squarrose peat moss/shaggy sphagnum
Bryophyte	*Sphagnum subsecundum*	twisted bog moss
Bryophyte	*Sphagnum teres*	thin-leafed peat moss
Bryophyte	*Sphagnum warnstorfii*	Warnstorf’s peat moss
Bryophyte	*Sphagnum wulfianum*	peat moss
Bryophyte	*Splachnum ampullaceum*	flagon-fruited splachnum
Bryophyte	*Splachnum luteum*	yellow collar moss
Bryophyte	*Splachnum rubrum*	red collar moss
Bryophyte	*Splachnum vasculosum*	large-fruited splachnum
Bryophyte	*Tetraphis pellucida*	common four-tooth moss
Bryophyte	*Tetraplodon mnioides*	brown tapering splachnum
Bryophyte	*Thuidium recognitum*	hook-leaf fern moss
Bryophyte	*Tomentypnum nitens*	golden fuzzy fen moss
Bryophyte	*Warnstorfia exannulata*	marsh hook moss
Bryophyte	*Warnstorfia fluitans*	water hook moss

Strata	Scientific Name	Common name
Epiphyte	*Amandinea punctata*	button lichen
Epiphyte	*Arthonia patellulata*	aspen comma
Epiphyte	*Bryoria capillaris*	
Epiphyte	*Bryoria chalybeiformis*	
Epiphyte	*Bryoria furcellata*	(spinulose horsehair)
Epiphyte	*Bryoria fuscescens*	speckled horsehair
Epiphyte	*Bryoria glabra*	
Epiphyte	*Bryoria lanestris*	brittle horsehair
Epiphyte	*Bryoria simplicior*	simple horsehair
Epiphyte	*Buellia disciformis*	
Epiphyte	*Caloplaca cerina*	crusted orange lichen
Epiphyte	*Caloplaca holocarpa*	
Epiphyte	*Candelariella vitellina*	
Epiphyte	*Cladina mitis*	green/yellow reindeer lichen
Epiphyte	*Cladina rangiferina*	grey reindeer lichen
Epiphyte	*Cladina stellaris*	northern/star reindeer lichen
Epiphyte	*Cladonia bacilliformis*	yellow tiny toothpick cladonia
Epiphyte	*Cladonia botrytes*	stump cladonia
Epiphyte	*Cladonia cervicornis*	whorled cup lichen
Epiphyte	*Cladonia chlorophaea*	false pixie-cup
Epiphyte	*Cladonia cornuta*	horn cladonia
Epiphyte	*Cladonia crispata*	shrub funnel cladonia
Epiphyte	*Cladonia cristatella*	(skinny) British soldiers
Epiphyte	*Cladonia cyanipes*	
Epiphyte	*Cladonia deformis*	deformed cup
Epiphyte	*Cladonia fimbriata*	(tall false pixie-cup)
Epiphyte	*Cladonia gracilis ssp turbinata*	brown-foot cladonia
Epiphyte	*Cladonia grayi*	
Epiphyte	*Cladonia macilenta*	scarlet toothpick cladonia
Epiphyte	*Cladonia multiformis*	seive cladonia
Epiphyte	*Cladonia pleurota*	(powdery red pixie-cup)
Epiphyte	*Cladonia pocillum*	(squamulose brown pixie-cup)
Epiphyte	*Cladonia pyxidata*	brown pixie-cup
Epiphyte	*Cladonia subulata*	tall toothpick cladonia
Epiphyte	*Cladonia sulphurina*	sulphur cup
Epiphyte	*Evernia mesomorpha*	spuce moss/northern perfume
Epiphyte	*Flavocetraria nivalis*	flattened snow lichen
Epiphyte	*Flavopunctelia flaventior*	green speckleback
Epiphyte	*Hypocenomyce scalaris*	common shingle
Epiphyte	*Hypogymnia austerodes*	
Epiphyte	*Hypogymnia physodes*	monk’s hood lichen/hooded tube
Epiphyte	*Imshaugia aleurites*	floury starburst
Epiphyte	*Lecanora allophana*	
Epiphyte	*Lecanora circumborealis*	rim lichen
Epiphyte	*Lecanora fuscescens*	
Epiphyte	*Lecanora hybocarpa*	
Epiphyte	*Lecanora impudens*	

Strata	Scientific Name	Common name
Epiphyte	*Lecanora piniperda*	
Epiphyte	*Lecanora pulicaris*	
Epiphyte	*Lecanora symmicta*	
Epiphyte	*Lecidella euphorea*	
Epiphyte	*Leptogium saturninum*	(tree-base kidney)
Epiphyte	*Melanelia exasperata*	
Epiphyte	*Melanelia fuliginosa*	
Epiphyte	*Melanelia septentrionalis*	northern brown lichen
Epiphyte	*Melanelia subargentifera*	
Epiphyte	*Melanelia subaurifera*	
Epiphyte	*Melanelia subaurifera*	
Epiphyte	*Micarea denigrata*	
Epiphyte	*Mycobilimbia hypnorum*	
Epiphyte	*Ochrolechia androgyna*	
Epiphyte	*Omphalina umbellifera*	
Epiphyte	*Parmelia sulcata*	waxpaper lichen/powdered shield
Epiphyte	*Parmeliopsis ambigua*	green starburst
Epiphyte	*Parmeliopsis hyperopta*	grey starburst
Epiphyte	*Peltigera aphthosa*	freckle pelt/studded leather lichen
Epiphyte	*Peltigera canina*	dog pelt/dog lichen
Epiphyte	*Peltigera didactyla*	temporary pelt/small felt lichen
Epiphyte	*Peltigera neopolydactyla*	frog pelt/finger felt lichen
Epiphyte	*Peltigera ponojensis*	
Epiphyte	*Peltigera rufescens*	felt pelt
Epiphyte	*Peltigera scabrosa*	rough pelt
Epiphyte	*Phaeocalicium populneum*	
Epiphyte	*Phaeophyscia ciliata*	
Epiphyte	*Phaeophyscia orbicularis*	granulated shadow
Epiphyte	*Physcia adscendens*	hooded rosette
Epiphyte	*Physcia aipolia*	grey-eyed rosette
Epiphyte	*Placynthiella uliginosa*	
Epiphyte	*Pseudevernia consocians*	
Epiphyte	*Ramalina dilacerata*	punctured gristle
Epiphyte	*Rinodina pyrina*	
Epiphyte	*Rinodina septentrionalis*	
Epiphyte	*Trapeliopsis granulosa*	
Epiphyte	*Tuckermannopsis americana*	fringed ruffle
Epiphyte	*Tuckermannopsis sepincola*	
Epiphyte	*Usnea cavernosa*	pitted old man's beard
Epiphyte	*Usnea filipendula*	old man's beard
Epiphyte	*Usnea glabrescens*	old man's beard
Epiphyte	*Usnea hirta*	sugary/shaggy old man's beard
Epiphyte	*Usnea lapponica*	powdery old man's beard
Epiphyte	*Usnea scabrata*	scruffy old man's beard
Epiphyte	*Usnea subfloridana*	(isidiate and sorediate) old man's beard
Epiphyte	*Usnea substerilis*	old man's beard

Strata	Scientific Name	Common name
Epiphyte	*Vulpicida pinastri*	powdered sunshine
Epiphyte	*Xanthoria fallax*	powdered orange lichen
Epiphyte	*Xylographa parallela*	black woodscript lichen
Forb	*Achillea millefolium*	common yarrow
Forb	*Achillea sibirica*	many-flowered yarrow
Forb	*Actaea rubra*	red and white baneberry
Forb	*Anemone canadensis*	Canada anemone
Forb	*Anemone parviflora*	small woodanemone
Forb	*Aquilegia brevistyla*	blue columbine
Forb	*Aralia nudicaulis*	wild sarsaparilla
Forb	*Arnica cordifolia*	heart-leaved arnica
Forb	*Aster ciliolatus*	Lindley's aster
Forb	*Aster conspicuus*	showy aster
Forb	*Aster puniceus*	purple-stemmed aster
Forb	*Athyrium filix-femina*	lady fern
Forb	*Bidens cernua*	nodding beggarticks
Forb	*Botrychium lunaria*	moonwort
Forb	*Botrychium minganense*	Mingan grapefern
Forb	*Calla palustris*	water arum
Forb	*Callitriche hermaphroditica*	northern water-starwort
Forb	*Callitriche verna*	vernal water-starwort
Forb	*Caltha natans*	floating marsh-marigold
Forb	*Caltha palustris*	marsh-marigold
Forb	*Cardamine pensylvanica*	bitter cress
Forb	*Chrysanthemum leucanthemum*	ox-eye daisy
Forb	*Chrysosplenium iowense*	golden saxifrage
Forb	*Chrysosplenium tetrandrum*	green saxifrage
Forb	*Cicuta bulbifera*	bulb-bearing water-hemlock
Forb	*Cicuta maculata*	water-hemlock
Forb	*Circaea alpina*	small enchanter's nightshade
Forb	*Cirsium arvense*	creeping thistle
Forb	*Corallorhiza trifida*	pale coralroot
Forb	*Cornus canadensis*	bunchberry
Forb	*Cornus stolonifera*	red-osier dogwood
Forb	*Delphinium glaucum*	tall larkspur
Forb	*Diphasiastrum complanatum*	ground-cedar
Forb	*Disporum trachycarpum*	fairybells
Forb	*Drosera anglica*	oblong-leaved sundew
Forb	*Drosera linearis*	slender-leaved sundew
Forb	*Drosera rotundifolia*	round-leaved sundew
Forb	*Dryopteris assimilis*	broad spinulose shield fern
Forb	*Dryopteris carthusiana*	narrow spinulose shield fern
Forb	*Epilobium angustifolium*	common fireweed
Forb	*Epilobium ciliatum*	northern willowherb
Forb	*Epilobium glaberrimum*	
Forb	*Epilobium leptophyllum*	narrow-leaved willowherb
Forb	*Epilobium palustre*	marsh willowherb

Strata	Scientific Name	Common name
Forb	*Epilobium paniculatum*	annual willowherb
Forb	*Equisetum arvense*	common horsetail
Forb	*Equisetum arvense*	common horsetail
Forb	*Equisetum fluviatile*	swamp horsetail
Forb	*Equisetum hyemale*	common scouring-rush
Forb	*Equisetum pratense*	meadow horsetail
Forb	*Equisetum scirpoides*	dwarf scouring-rush
Forb	*Equisetum sylvaticum*	woodland horsetail
Forb	*Erigeron acris*	northern daisy fleabane
Forb	*Erysimum cheiranthoides*	wormseed mustard
Forb	*Euphrasia arctica*	eyebright
Forb	*Fragaria vesca*	woodland strawberry
Forb	*Fragaria virginiana*	wild strawberry
Forb	*Galium boreale*	northern bedstraw
Forb	*Galium trifidum*	small bedstraw
Forb	*Galium triflorum*	sweet-scented bedstraw
Forb	*Gentianella amarella*	felwort
Forb	*Gentianella crinita*	fringed gentian
Forb	*Geocaulon lividum*	northern bastard toadflax
Forb	*Geranium bicknellii*	Bicknell’s geranium
Forb	*Geum aleppicum*	yellow avens
Forb	*Geum macrophyllum*	large-leaved yellow avens
Forb	*Geum rivale*	purple avens
Forb	*Goodyera repens*	lesser rattlesnake plantain
Forb	*Gymnocarpium dryopteris*	oak fern
Forb	*Halenia deflexa*	spurred gentian
Forb	*Heracleum lanatum*	cow parsnip
Forb	*Hieracium umbellatum*	narrow-leaved hawkweed
Forb	*Hippuris vulgaris*	common mare’s-tail
Forb	*Impatiens capensis*	spotted touch-me-not
Forb	*Lathyrus ochroleucus*	cream-colored vetchling
Forb	*Lathyrus venosus*	purple peavine
Forb	*Lemna minor*	common duckweed
Forb	*Limosella aquatica*	mudwort
Forb	*Linnaea borealis*	twinflower
Forb	*Listera borealis*	northern twayblade
Forb	*Listera cordata*	heart-leaved twayblade
Forb	*Lonicera caerulea*	fly honeysuckle
Forb	*Lycopodium annotinum*	stiff club-moss
Forb	*Lycopodium clavatum*	running club-moss
Forb	*Lycopodium obscurum*	ground-pine
Forb	*Lycopus uniflorus*	northern water-horehound
Forb	*Maianthemum canadense*	wild lily-of-the-valley
Forb	*Matricaria matricarioides*	pineappleweed
Forb	*Matteuccia struthiopteris*	ostrich fern
Forb	*Medicago sativa*	alfalfa
Forb	*Melampyrum lineare*	cow-wheat

Strata	Scientific Name	Common name
Forb	*Melilotus alba*	white sweet-clover
Forb	*Menyanthes trifoliata*	buck-bean
Forb	*Mertensia paniculata*	tall lungwort
Forb	*Mitella nuda*	bishop's-cap
Forb	*Moehringia lateriflora*	blunt-leaved sandwort
Forb	*Moneses uniflora*	one-flowered wintergreen
Forb	*Orthilia secunda*	one-sided wintergreen
Forb	*Parnassia palustris*	northern grass-of-parnassus
Forb	*Pedicularis groenlandica*	elephant's-head
Forb	*Pedicularis labradorica*	Labrador lousewort
Forb	*Pedicularis parviflora*	swamp lousewort
Forb	*Petasites frigidus var frigidus*	sweet coltsfoot
Forb	*Petasites frigidus var palmatus*	palmate-leaved coltsfoot
Forb	*Petasites frigidus var sagittatus*	arrow-leaved coltsfoot
Forb	*Picea mariana*	black spruce
Forb	*Plantago major*	common plantain
Forb	*Platanthera dilatata*	tall white bog orchid
Forb	*Platanthera hyperborea*	northern green bog orchid
Forb	*Platanthera obtusata*	blunt-leaved bog orchid
Forb	*Platanthera orbiculata*	round-leaved bog orchid
Forb	*Polemonium acutiflorum*	tall Jacob's-ladder
Forb	*Polygonum amphibium*	water smartweed
Forb	*Polygonum lapathifolium*	pale persicaria
Forb	*Potamogeton foliosus*	leafy pondweed
Forb	*Potamogeton gramineus*	various-leaved pondweed
Forb	*Potamogeton pectinatus*	sago pondweed
Forb	*Potamogeton pusillus*	small-leaf pondweed
Forb	*Potamogeton richardsonii*	clasping-leaf pondweed
Forb	*Potamogeton vaginatus*	large-sheath pondweed
Forb	*Potentilla gracilis*	graceful cinquefoil
Forb	*Potentilla norvegica*	rough cinquefoil
Forb	*Potentilla palustris*	marsh cinquefoil
Forb	*Potentilla tridentata*	three-toothed cinquefoil
Forb	*Primula mistassinica*	dwarf Canadian primrose
Forb	*Pyrola asarifolia*	common pink wintergreen
Forb	*Pyrola chlorantha*	greenish-flowered wintergreen
Forb	*Ranunculus gmelinii*	yellow water-crowfoot
Forb	*Ranunculus lapponicus*	Lapland buttercup
Forb	*Ranunculus macounii*	Macoun's buttercup
Forb	*Ranunculus sceleratus*	celery-leaved buttercup
Forb	*Rhinanthus borealis*	yellow rattle
Forb	*Rubus arcticus*	dwarf raspberry
Forb	*Rubus chamaemorus*	cloudberry
Forb	*Rubus pedatus*	dwarf bramble
Forb	*Rubus pubescens*	dewberry
Forb	*Rumex britannica*	water dock
Forb	*Rumex occidentalis*	western dock

Strata	Scientific Name	Common name
Forb	*Scirpus microcarpus*	small-fruited bulrush
Forb	*Scutellaria galericulata*	marsh skullcap
Forb	*Senecio eremophilus*	cut-leaved ragwort
Forb	*Senecio pauciflorus*	few-flowered ragwort
Forb	*Senecio pauperculus*	balsam groundsel
Forb	*Smilacina trifolia*	three-leaved Solomon's-seal
Forb	*Solidago simplex*	
Forb	*Sonchus arvensis*	perennial sow-thistle
Forb	*Sparganium angustifolium*	narrow-leaved bur-reed
Forb	*Sparganium eurycarpum*	giant bur-reed
Forb	*Sphagnum angustifolium*	poor fen peat moss
Forb	*Spiranthes romanzoffiana*	hooded ladies'-tresses
Forb	*Stachys palustris*	marsh hedge-nettle
Forb	*Stellaria calycantha*	northern stitchwort
Forb	*Stellaria crassifolia*	fleshy stitchwort
Forb	*Stellaria longifolia*	long-leaved chickweed
Forb	*Stellaria longipes*	long-stalked chickweed
Forb	*Taraxacum officinale*	common dandelion
Forb	*Thalictrum dasycarpum*	tall meadowrue
Forb	*Thalictrum sparsiflorum*	flat-fruited meadowrue
Forb	*Thalictrum venulosum*	veiny meadowrue
Forb	*Trientalis borealis*	northern starflower
Forb	*Trientalis europaea*	Arctic starflower
Forb	*Trifolium hybridum*	alsike clover
Forb	*Trifolium pratense*	red clover
Forb	*Triglochin maritima*	seaside arrow-grass
Forb	*Typha latifolia*	common cattail
Forb	*Urtica dioica*	common nettle
Forb	*Utricularia intermedia*	flat-leaved bladderwort
Forb	*Utricularia minor*	small bladderwort
Forb	*Utricularia vulgaris*	common bladderwort
Forb	*Veronica americana*	American brooklime
Forb	*Vicia americana*	wild vetch
Forb	*Vicia americana*	wild vetch
Forb	*Viola adunca*	early blue violet
Forb	*Viola canadensis*	western Canada violet
Forb	*Viola palustris*	marsh violet
Forb	*Viola renifolia*	kidney-leaved violet
Graminoid	*Agropyron pectiniforme*	crested wheatgrass
Graminoid	*Agrostis scabra*	rough hairgrass
Graminoid	*Agrostis stolonifera*	redtop
Graminoid	*Alopecurus aequalis*	short-awned foxtail
Graminoid	*Beckmannia syzigachne*	slough grass
Graminoid	*Bromus ciliatus*	fringed brome
Graminoid	*Bromus inermis*	awnless brome
Graminoid	*Calamagrostis canadensis*	bluejoint
Graminoid	*Calamagrostis inexpansa*	northern reedgrass

Strata	Scientific Name	Common name
Graminoid	*Calamagrostis purpurascens*	purple reedgrass
Graminoid	*Carex aenea*	silvery-flowered sedge
Graminoid	*Carex aquatilis*	water sedge
Graminoid	*Carex atherodes*	awned sedge
Graminoid	*Carex aurea*	golden sedge
Graminoid	*Carex brunnescens*	brownish sedge
Graminoid	*Carex canescens*	short sedge
Graminoid	*Carex capillaris*	hair-like sedge
Graminoid	*Carex chordorrhiza*	prostrate sedge
Graminoid	*Carex concinna*	beautiful sedge
Graminoid	*Carex deflexa*	bent sedge
Graminoid	*Carex deweyana*	Dewey's sedge
Graminoid	*Carex diandra*	two-stamened sedge
Graminoid	*Carex disperma*	two-seeded sedge
Graminoid	*Carex gynocrates*	northern bog sedge
Graminoid	*Carex interior*	inland sedge
Graminoid	*Carex leptalea*	bristle-stalked sedge
Graminoid	*Carex limosa*	mud sedge
Graminoid	*Carex loliacea*	rye-grass sedge
Graminoid	*Carex norvegica*	Norway sedge
Graminoid	*Carex pauciflora*	few-flowered sedge
Graminoid	*Carex paupercula*	
Graminoid	*Carex prairea*	prairie sedge
Graminoid	*Carex rostrata*	beaked sedge
Graminoid	*Carex sartwellii*	Sartwell's sedge
Graminoid	*Carex scoparia*	broom sedge
Graminoid	*Carex siccata*	hay sedge
Graminoid	*Carex tenera*	broad-fruited sedge
Graminoid	*Carex trisperma*	three-seeded sedge
Graminoid	*Carex utriculata*	small bottle sedge
Graminoid	*Carex vaginata*	sheathed sedge
Graminoid	*Carex vesicaria*	blister sedge
Graminoid	*Carex xerantica*	white-scaled sedge
Graminoid	*Cinna latifolia*	drooping wood-reed
Graminoid	*Deschampsia caespitosa*	tufted hairgrass
Graminoid	*Eleocharis acicularis*	needle spike-rush
Graminoid	*Eleocharis palustris*	creeping spike-rush
Graminoid	*Elymus canadensis*	Canada wildrye
Graminoid	*Elytrigia repens*	creeping wildrye
Graminoid	*Eriophorum angustifolium*	
Graminoid	*Eriophorum chamissonis*	russett cottongrass
Graminoid	*Eriophorum gracile*	slender cottongrass
Graminoid	*Eriophorum vaginatum*	sheathed cottongrass
Graminoid	*Eriophorum viridi-carinatum*	thin-leaved cottongrass
Graminoid	*Festuca rubra*	red fescue
Graminoid	*Festuca saximontana*	Rocky Mountain fescue
Graminoid	*Glyceria borealis*	northern manna grass

Strata	Scientific Name	Common name
Graminoid	*Glyceria grandis*	common tall manna grass
Graminoid	*Glyceria pulchella*	graceful manna grass
Graminoid	*Glyceria striata*	fowl manna grass
Graminoid	*Gymnocarpium dryopteris*	oak fern
Graminoid	*Hordeum jubatum*	foxtail barley
Graminoid	*Juncus alpinoarticulatus*	alpine rush
Graminoid	*Juncus bufonius*	toad rush
Graminoid	*Juncus filiformis*	thread rush
Graminoid	*Juncus stygius var americanus*	marsh rush
Graminoid	*Leymus innovatus*	hairy wildrye
Graminoid	*Luzula multiflora*	field wood-rush
Graminoid	*Luzula parviflora*	small-flowered wood-rush
Graminoid	*Phalaris arundinacea*	reed canary grass
Graminoid	*Phleum pratense*	timothy
Graminoid	*Poa interior*	inland bluegrass
Graminoid	*Poa palustris*	fowl bluegrass
Graminoid	*Poa pratensis*	Kentucky bluegrass
Graminoid	*Scheuchzeria palustris*	scheuchzeria
Graminoid	*Schoenoplectus acutus*	great bulrush
Graminoid	*Schoenoplectus tabernaemontani*	common great bulrush
Graminoid	*Scirpus cyperinus*	wool-grass
Graminoid	*Scirpus hudsonianus*	Hudson Bay bulrush
Graminoid	*Scirpus microcarpus*	small-fruited bulrush
Lichen	*Bryoria lanestris*	brittle horsehair
Lichen	*Cetraria ericetorum*	(margined icelandmoss)
Lichen	*Cladina mitis*	green/yellow reindeer lichen
Lichen	*Cladina rangiferina*	grey reindeer lichen
Lichen	*Cladina stellaris*	northern/star reindeer lichen
Lichen	*Cladina stygia*	(black-based) reindeer lichen
Lichen	*Cladonia amaurocraea*	(cup-forming prickle cladonia)
Lichen	*Cladonia bacilliformis*	yellow tiny toothpick cladonia
Lichen	*Cladonia borealis*	red/boreal pixie-cup
Lichen	*Cladonia botrytes*	stump cladonia
Lichen	*Cladonia cariosa*	ribbed cladonia/torn club cladonia
Lichen	*Cladonia carneola*	
Lichen	*Cladonia cenotea*	powdered funnel cladonia
Lichen	*Cladonia cervicornis*	whorled cup lichen
Lichen	*Cladonia chlorophaea*	false pixie-cup
Lichen	*Cladonia coniocraea*	tiny toothpick cladonia
Lichen	*Cladonia cornuta*	horn cladonia
Lichen	*Cladonia crispata*	shrub funnel cladonia
Lichen	*Cladonia cristatella*	(skinny) British soldiers
Lichen	*Cladonia cyanipes*	
Lichen	*Cladonia deformis*	deformed cup
Lichen	*Cladonia ecmocyna*	orange-foot cladonia
Lichen	*Cladonia fimbriata*	(tall false pixie-cup)

Strata	Scientific Name	Common name
Lichen	*Cladonia gracilis ssp elongata*	
Lichen	*Cladonia gracilis ssp turbinata*	brown-foot cladonia
Lichen	*Cladonia gracilis ssp turbinata*	brown-foot cladonia
Lichen	*Cladonia grayi*	
Lichen	*Cladonia macilenta*	scarlet toothpick cladonia
Lichen	*Cladonia merochlorophaea*	
Lichen	*Cladonia multiformis*	seive cladonia
Lichen	*Cladonia multiformis*	seive cladonia
Lichen	*Cladonia norvegica*	
Lichen	*Cladonia phyllophora*	black-foot cladonia
Lichen	*Cladonia pleurota*	(powdery red pixie-cup)
Lichen	*Cladonia pyxidata*	brown pixie-cup
Lichen	*Cladonia rei*	
Lichen	*Cladonia scabriuscula*	shingled cladonia
Lichen	*Cladonia subulata*	tall toothpick cladonia
Lichen	*Cladonia sulphurina*	sulphur cup
Lichen	*Cladonia umbricola*	
Lichen	*Cladonia uncialis*	prickle cladonia
Lichen	*Evernia mesomorpha*	spuce moss/northern perfume
Lichen	*Flavocetraria cucullata*	curled snow lichen
Lichen	*Flavocetraria nivalis*	flattened snow lichen
Lichen	*Icmadophila ericetorum*	fairy puke/spraypaint
Lichen	*Nephroma bellum*	
Lichen	*Nephroma resupinatum*	
Lichen	*Omphalina umbellifera*	
Lichen	*Parmelia sulcata*	waxpaper lichen/powdered shield
Lichen	*Parmeliopsis hyperopta*	grey starburst
Lichen	*Peltigera aphthosa*	freckle pelt/studded leather lichen
Lichen	*Peltigera canina*	dog pelt/dog lichen
Lichen	*Peltigera conspersa*	
Lichen	*Peltigera didactyla*	temporary pelt/small felt lichen
Lichen	*Peltigera elisabethae*	(lobuled pelt)
Lichen	*Peltigera extenuata*	
Lichen	*Peltigera kristinssonii*	
Lichen	*Peltigera leucophlebia*	(veined freckle pelt)
Lichen	*Peltigera malacea*	apple pelt/boxboard felt lichen
Lichen	*Peltigera membranacea*	
Lichen	*Peltigera neckeri*	(shiny powdered pelt)
Lichen	*Peltigera neopolydactyla*	frog pelt/finger felt lichen
Lichen	*Peltigera ponojensis*	
Lichen	*Peltigera praetextata*	
Lichen	*Peltigera retifoveata*	(spongy pelt)
Lichen	*Peltigera rufescens*	felt pelt
Lichen	*Peltigera scabrosa*	rough pelt
Lichen	*Polytrichum strictum*	slender hair-cap
Lichen	*Stereocaulon tomentosum*	woolly coral
Lichen	*Trapeliopsis granulosa*	

Strata	Scientific Name	Common name
Shrub	*Abies balsamea*	balsam fir
Shrub	*Alnus incana ssp tenuifolia*	river alder
Shrub	*Alnus viridis*	green alder
Shrub	*Andromeda polifolia*	bog rosemary
Shrub	*Arctostaphylos uva-ursi*	common bearberry
Shrub	*Betula glandulosa*	bog birch
Shrub	*Betula occidentalis*	water birch
Shrub	*Betula papyrifera*	white birch
Shrub	*Betula pumila*	dwarf birch
Shrub	*Chamaedaphne calyculata*	leatherleaf
Shrub	*Cornus stolonifera*	red-osier dogwood
Shrub	*Corylus cornuta*	beaked hazelnut
Shrub	*Empetrum nigrum*	crowberry
Shrub	*Gaultheria hispidula*	creeping snowberry
Shrub	*Kalmia polifolia*	northern laurel
Shrub	*Larix laricina*	tamarack
Shrub	*Ledum groenlandicum*	common Labrador tea
Shrub	*Lonicera dioica*	twining honeysuckle
Shrub	*Lonicera involucrata*	bracted honeysuckle
Shrub	*Myrica gale*	sweet gale
Shrub	*Oxycoccus microcarpus*	small bog cranberry
Shrub	*Oxycoccus quadripetalus*	large bog cranberry
Shrub	*Picea glauca*	white spruce
Shrub	*Picea mariana*	black spruce
Shrub	*Pinus banksiana*	jack pine
Shrub	*Pinus contorta*	lodgepole pine
Shrub	*Populus balsamifera*	balsam poplar
Shrub	*Populus tremuloides*	aspen
Shrub	*Prunus pensylvanica*	pin cherry
Shrub	*Prunus virginiana*	choke cherry
Shrub	*Rhamnus alnifolia*	alder-leaved buckthorn
Shrub	*Ribes americanum*	wild black currant
Shrub	*Ribes glandulosum*	skunk currant
Shrub	*Ribes hudsonianum*	northern blackcurrant
Shrub	*Ribes lacustre*	bristly black currant
Shrub	*Ribes oxyacanthoides*	northern gooseberry
Shrub	*Ribes triste*	wild redcurrant
Shrub	*Rosa acicularis*	prickly rose
Shrub	*Rosa woodsii*	common wild rose
Shrub	*Rubus chamaemorus*	cloudberry
Shrub	*Rubus idaeus*	wild red raspberry
Shrub	*Rubus pubescens*	dewberry
Shrub	*Salix arbusculoides*	shrubby willow
Shrub	*Salix bebbiana*	beaked willow
Shrub	*Salix candida*	hoary willow
Shrub	*Salix discolor*	pussy willow
Shrub	*Salix drummondiana*	Drummond’s willow

Strata	Scientific Name	Common name
Shrub	*Salix exigua*	sandbar willow
Shrub	*Salix glauca*	smooth willow
Shrub	*Salix lucida*	shining willow
Shrub	*Salix lutea*	yellow willow
Shrub	*Salix maccalliana*	velvet-fruited willow
Shrub	*Salix myrtillifolia*	myrtle-leaved willow
Shrub	*Salix pedicellaris*	bog willow
Shrub	*Salix petiolaris*	basket willow
Shrub	*Salix planifolia*	flat-leaved willow
Shrub	*Salix prolixa*	Mackenzie's willow
Shrub	*Salix pseudomonticola*	false mountain willow
Shrub	*Salix pyrifolia*	balsam willow
Shrub	*Salix scouleriana*	Scouler's willow
Shrub	*Salix serissima*	autumn willow
Shrub	*Shepherdia canadensis*	Canada buffaloberry
Shrub	*Sorbus scopulina*	western mountain-ash
Shrub	*Spiraea betulifolia*	white meadowsweet
Shrub	*Spiranthes romanzoffiana*	hooded ladies'-tresses
Shrub	*Vaccinium caespitosum*	dwarf bilberry
Shrub	*Vaccinium membranaceum*	tall bilberry
Shrub	*Vaccinium myrtilloides*	common blueberry
Shrub	*Vaccinium vitis-idaea*	bog cranberry
Shrub	*Viburnum edule*	low-bush cranberry
Tree	*Abies balsamea*	balsam fir
Tree	*Abies balsamea*	balsam fir
Tree	*Abies balsamea*	balsam fir
Tree	*Alnus incana ssp tenuifolia*	river alder
Tree	*Alnus incana ssp tenuifolia*	river alder
Tree	*Alnus viridis*	green alder
Tree	*Betula glandulosa*	bog birch
Tree	*Betula occidentalis*	water birch
Tree	*Betula papyrifera*	white birch
Tree	*Betula papyrifera*	white birch
Tree	*Betula papyrifera*	white birch
Tree	*Betula pumila*	dwarf birch
Tree	*Larix laricina*	tamarack
Tree	*Larix laricina*	tamarack
Tree	*Larix laricina*	tamarack
Tree	*Picea glauca*	white spruce
Tree	*Picea glauca*	white spruce
Tree	*Picea glauca*	white spruce
Tree	*Picea mariana*	black spruce
Tree	*Picea mariana*	black spruce
Tree	*Picea mariana*	black spruce
Tree	*Pinus banksiana*	jack pine
Tree	*Pinus banksiana*	jack pine
Tree	*Pinus banksiana*	jack pine

Strata	Scientific Name	Common name
Tree	*Pinus contorta*	lodgepole pine
Tree	*Pinus contorta*	lodgepole pine
Tree	*Populus balsamifera*	balsam poplar
Tree	*Populus balsamifera*	balsam poplar
Tree	*Populus balsamifera*	balsam poplar
Tree	*Populus tremuloides*	aspen
Tree	*Populus tremuloides*	aspen
Tree	*Populus tremuloides*	aspen
Tree	*Prunus pensylvanica*	pin cherry
Tree	*Salix arbusculoides*	shrubby willow
Tree	*Salix bebbiana*	beaked willow
Tree	*Salix discolor*	pussy willow
Tree	*Salix exigua*	sandbar willow
Tree	*Salix lutea*	yellow willow
Tree	*Salix maccalliana*	velvet-fruited willow
Tree	*Salix planifolia*	flat-leaved willow
Tree	*Salix prolixa*	Mackenzie's willow
Tree	*Salix pyrifolia*	balsam willow
Tree	*Salix scouleriana*	Scouler's willow
Tree	*Salix scouleriana*	Scouler's willow
Tree	*Salix serissima*	autumn willow

Appendix 3 – Description of Ecosites and Ecosite Phases observed in the Great Divide SAGD Expansion Project Area

Blueberry ecosite (b)

Ecosite b parent material is often coarse-textured glaciofluvial, resulting in a subxeric to submesic moisture regime. The nutrient level of the soil is medium to poor. The canopy is often pine, aspen and paper birch. The stand may succeed to a white spruce stand; however, this is a slow process because of the dryness of the ecosite. The ecosite is well to moderately-well drained. The organic layer ranges from 1-15 cm in thickness. Mean species richness is 24.6, Shannon diversity is 2.8 and evenness is 0.9. Two ecosite phases and three plant community types were encountered in the field survey.

b1 blueberry jack pine-aspen

Ecosite phase b1 occupies 7.0% (1,081.9 ha) of the LSA, and is dominated by jack pine and aspen in the canopy, and blueberry and bog cranberry in the understory. Some paper birch may also be present. The moisture regime in this ecosite phase varies between submesic, subxeric and mesic, and the nutrient regime can be poor to medium. The ecosite phase is moderately to well drained and usually has a sandy soil texture, or occasionally loamy sand, sandy loam or sandy clay loam. Mean species richness is 21.9, Shannon diversity index is 2.6, and evenness is 0.9. Four unique species were found in this phase and two community types were found in the LSA.

b1.2 jack pine-aspen/blueberry-green alder

b1.3 jack pine-aspen/ blueberry-Labrador tea

b2 blueberry aspen-paper birch

The blueberry aspen-paper birch ecosite phase occupies 0.1% (18.9) ha of the LSA. This phase is dominated by aspen and paper birch with some white spruce in the canopy, and blueberry, bearberry and Labrador tea in the understory. The moisture regime ranges between subxeric to submesic with a nutrient regime ranging from poor to rich. The soil texture varies between sand and clay in the form of sandy loam, loamy sand, and sandy clay. The mean species richness is 28.5, Shannon diversity is 3.0, and evenness is 0.9. Five unique species were present in this phase. One community type from this phase was found in the LSA.

b2.3 aspen-paper birch/ blueberry-Labrador tea

b3 blueberry aspen-white spruce

The blueberry aspen-white spruce ecosite phase occupies 0.02% (3.1 ha) of the LSA. This phase is dominated by aspen and white spruce in the canopy, and blueberry, bearberry and bog cranberry and prickly rose in the understory. The moisture regime ranges between subxeric to mesic with a nutrient regime ranging from poor to medium. The soil texture varies between loamy sand and sand. No plots were completed in the b3 ecosite phase.

b4 blueberry white spruce-jack pine

Ecosite phase b4 occupies 0.04% (6.1 ha) of the LSA and is dominated by white spruce and jack pine in the canopy, and bearberry, blueberry and green alder in the understory. Some paper birch may also be present. The moisture regime in this ecosite phase varies between xeric and submesic, and the nutrient regime tends to be poor. The ecosite phase is well to rapidly drained and usually has a sandy soil texture, or occasionally sandy or silty loam. No plots were completed in the b4 ecosite phase.

Labrador tea-mesic ecosite (c)

Ecosite c has nutrient-poor and relatively acidic surface soils. The moisture regime ranges from subxeric to subhygric. It is often dominated by Labrador tea or bog cranberry in the understory. The parent material is dominantly morainal or glaciofluvial. The area is upland, located typically on mid to upper slopes. The canopy usually consists of two dominant species: jack pine and black spruce. Jack pine, the faster growing species, typically comprises the higher layer, while black spruce, the slower species, often forms a secondary canopy beneath the pine. This ecosite is considered mesic, with no mottles in the top 25 cm of the soil profile. The organic layer is usually between 6-15 cm deep, although occasionally there can be less than 6 cm of organic matter. Mean species richness is 26.3, Shannon diversity is 2.9, and evenness is 0.9. One ecosite phase and three plant community types were encountered in the field survey.

c1 jack pine-black spruce/Labrador tea – mesic

Ecosite phase c1 is the most common phase in the LSA, occupying 21.8% (3,357.8 ha). It is dominated by a typically two-tiered canopy of jack pine and black spruce. The understory is dominated by Labrador tea and bog cranberry. The soil texture varies by location between sand, sandy loam, loamy sand, loam, sandy clay loam, clay loam and clay. The humus form is mor and peatymor. Mean species richness is 26.3, Shannon diversity is 2.9, and evenness is 0.9. Six unique species were found in this phase, and three community types were found within the LSA.

c1.1 jack pine-black spruce/Labrador tea/feather moss

c1.2 jack pine-black spruce/green alder/feather moss

c1.3 jack pine-black spruce/feather moss

Low-bush cranberry ecosite (d)

Ecosite d is considered the reference site of the Boreal Mixedwood because of its mesic moisture regime and medium nutrient regime. Parent material is usually moderately-fine to fine-textured till or glaciolacustrine. Drainage is moderately well to imperfect. The ecosite starts as a deciduous stand of aspen, balsam poplar and/or paper birch. Over time these stands succeed to white spruce and balsam fir with reduced understory structure and diversity. The organic layer is usually 6-15 cm thick. Species richness is 29.8 Shannon diversity is 3.1 and evenness is 0.9.Three ecosite phases and nine plant community types were encountered in the field survey.

d1 low-bush cranberry/aspen

Ecosite phase d1 occupies 0.5% (74.6 ha) of the LSA, and is dominated by aspen, with some balsam poplar, paper birch and white spruce present. The understory is dominated by prickly rose and low-bush cranberry. The moisture regime ranges from submesic to subhygric, but is usually mesic. The nutrient regime is medium to rich. The soil texture is finer than the previous ecosites consisting of silty to sandy clay loams. The mean species richness is 30.6, Shannon diversity is 3.0, and evenness is 0.9. Seven unique species were found. Four community types were found in the LSA.

d1.4 aspen/green alder

d1.5 aspen/ low-bush cranberry

d1.6 aspen/rose

d1.8 aspen/forb

d2 low-bush cranberry/aspen-white spruce

Ecosite phase d2 occupies 0.6% (92.2 ha) of the LSA and is dominated by aspen and white spruce; however, balsam poplar, paper birch, balsam fir and some black spruce may be present. The understory is dominated by low-bush cranberry and prickly rose. The nutrient regime ranges from poor to rich and the moisture regime is similar to ecosite phase d1. Soil texture ranges from sand to clay. Diversity and evenness are relatively high in this phase. Mean species richness is 33, Shannon diversity is 3.3 and evenness is 1.0. This status reflects the succession of this ecosite from pioneer to early seral stage with the presence of both pioneer species and early and mid-seral species that have begun to establish. There were four unique species found, and three community types were found in the LSA.

d2.3 aspen-white spruce/green alder

d2.4 aspen-white spruce/ low-bush cranberry

d2.7 aspen-white spruce/forb

d3 low-bush cranberry/white spruce

Ecosite phase d3 occupies 0.5% (82.3 ha) of the LSA. It is dominated by white spruce, but may also have some balsam fir, aspen, paper birch, balsam poplar, or black spruce present. The understory is dominated by twinflower and low-bush cranberry. Stair-step moss is a significant ground cover. The moisture regime is mesic to subhygric and the nutrient regime ranges from poor to rich, though most locations have a medium nutrient regime. Soil texture range is broad, ranging between clay and sandy loam with some silty loam. The mean species richness is 22.7, Shannon diversity is 2.8, and evenness is 0.9. Four unique species were found in this phase, and two plant community types were found within the LSA.

d3.4 white spruce/balsam fir/feather moss d3.5 white spruce/feather moss

Dogwood ecosite (e)

Ecosite e is subhygric and nutrient rich and is common on mid to lower slope positions or adjacent to water courses where it receives nutrient-rich seepage water for part of the growing season. Parent material is usually fine glaciolacustrine or till deposits. Drainage is generally well to imperfect. This ecosite tends to be the most productive in the Boreal Mixedwood, and plant communities tend to be high in species richness, diversity and cover. Succession in the dogwood ecosite is slow initially, due to the high grass, forb and shrub cover; however, once white spruce becomes established, growth rates are generally quite high. The e ecosite is very diverse with a mean species richness of 36.6, Shannon diversity of 3.2, and evenness of 0.9, and this reflects the high productivity of these sites. Two ecosite phases and three plant community types were encountered in the field survey.

e1 dogwood/balsam poplar-aspen

Ecosite phase e1 occupies 0.1% (16.6 ha) of the LSA. It is dominated by balsam poplar and aspen, however, white spruce and paper birch may also be present. The understory is dominated by dogwood, low-bush cranberry and prickly rose. Wild sarsaparilla, dewberry, and fireweed constitute the common forb species, and marsh reed grass is also often present. The nutrient regime ranges from medium to rich and the moisture regime is mesic to subhygric. Soil texture ranges from sand to clay. Ecosite phase e1 has the highest mean species richness (38.2), however, Shannon diversity is moderately high (3.1). High diversity is expected in this ecosite phase, as e ecosites are commonly found on mid to lower slopes or near water courses, receiving nutrient-rich seepage waters during the growing season (Beckingham and Archibald 1996). Evenness is 0.9, indicating that the majority of species are equitable in distribution in these sites. There were five unique species found in the e1 ecosite phase and two community types were found in the LSA.

e1.2 balsam poplar-aspen/bracted honeysuckle/fern

e1.3 balsam poplar-aspen/river alder/fern

e2 dogwood/balsam poplar-white spruce

Ecosite phase e2 occupies 0.1% (20.4 ha) of the LSA. It has a canopy dominated by balsam poplar and white spruce, and may contain lesser amounts of aspen, white birch, and balsam fir. The shrub layer may be diverse, with dogwood, low-bush cranberry, rose and bracted honeysuckle common. Wild sarsaparilla, dewberry, bunchberry, and bishop’s cap are common forbs, and marsh reed grass and feather mosses are also present. Soil texture ranges between clay, silty clay loam, clay loam, sandy clay loam, and sand. The moisture regime can be mesic to subhygric, and the nutrient regime may vary between medium and rich. The mean species richness is 31.0, Shannon diversity is 3.4, and the evenness is 1.0. There was one unique species found in this phase. One community type was found in the LSA.

e2.3 balsam poplar-white spruce/river alder-green alder/fern e3 dogwood white spruce

Ecosite phase e3 occupies 0.05% (7.6 ha) of the LSA and is dominated by white spruce. The understory is dominated by balsam fir; low-bush cranberry and prickly rose. Wild sarsaparilla, horsetail, and dewberry make up the common forb species, and marsh reed grass is also often present. The nutrient regime ranges from medium to rich and the moisture regime is mesic to subhygric. Soil texture ranges from sand to clay. No plots were completed in this phase.

Horsetail ecosite (f)

Ecosite f is nutrient rich and has a subhygric to hygric moisture regime. This ecosite is found on level sites or lower slopes in areas where water and nutrients are replenished by flooding or seepage. These sites usually have fluvial parent materials, gleysolic soils, and organic matter accumulation. Horsetails commonly form a blanket over the forest floor. Succession in f ecosites is controlled by high water content in soils, with white spruce forming the canopy in the last successional stage. Once trees are removed from this ecosite, rising water tables may make tree establishment difficult. Mean species richness in the horsetail ecosite is 34.0, Shannon diversity is 3.0 and evenness is 0.9.Three ecosite phases and three plant community types were encountered in the field survey.

f1 horsetail/balsam poplar-aspen

Ecosite phase f1 occupies 0.1% (11.9 ha) in the LSA. The canopy is dominated by balsam poplar and aspen, with lesser amounts of paper birch and white spruce. Willow, prickly rose, green/river alder, meadow horsetail, common horsetail, and marsh reed grass are found in this ecosite phase. Little to no moss is present in this ecosite phase. This phase has a hygric moisture regime and a medium to rich nutrient regime. Soil texture is generally silt, clay, silty clay, and loam. Mean Shannon diversity is 1.3, evenness is 0.5 and mean species richness is 17. Diversity in f ecosites is expected to be high; the low results found for calculated diversity in this ecosite phase is probably because only one site was surveyed. No unique species are present in this phase, and one community type was observed in the LSA.

f1.1 balsam poplar-aspen/horsetail

f2 horsetail/ balsam poplar-white spruce

The f2 ecosite phase occupies 0.1% (17.6 ha) of the LSA and has a canopy dominated by balsam poplar and white spruce with paper birch, aspen and balsam fir also potentially present. Low-bush cranberry, willow species, prickly rose, and dogwood are common shrub species in this phase. Meadow and common horsetail, wild sarsaparilla, bishop’s cap, bunchberry, marsh reed grass, and feather mosses are commonly found in the understory. Soil texture ranges from sand to clay. The moisture regime ranges between hygric and mesic, but is most commonly subhygric. The nutrient regime is medium to rich. Diversity in this ecosite phase is high; mean species richness is 37.5, Shannon diversity is 3.7, and evenness is 1.0. There were four unique species and one community type observed in the LSA.

f2.1 balsam poplar-aspen/horsetail

f3 horsetail/white spruce

The horsetail/white spruce ecosite phase occupies 0.1% (10.9 ha) of the LSA. The canopy is dominated by white spruce, but again, can have small amounts of balsam fir, aspen, balsam poplar, and white birch. Twin flower, prickly rose, low-bush cranberry, and currant make up the shrub layer, and meadow and common horsetail, bunchberry, and dewberry are the prominent forbs. Marsh reedgrass and sometimes sedges are also present with feather mosses. Soils are generally silty clay or clay, and the moisture regime can be mesic to hygric. Mean species richness is 35.0, Shannon diversity is 2.4, and evenness is 0.7. There was one unique species found in this phase and one community type was observed in the LSA.

f3.1 white spruce/horsetail

Labrador tea – subhygric ecosite (g)

Ecosite g is nutrient poor with poorly-drained soils. The soils are quite acidic, which is indicated by bog cranberry and Labrador tea. This site occurs on a number of soil types such as fine-textured till or glaciolacustrine deposits, coarse-textured glaciofluvial material, or on organic matter where Gleysolic soils are present. This ecosite is similar to the c ecosite; however, g occurs on lower topographic sites and its soils have mottles within the top 25 cm. The site is often dominated by black spruce rather than pine. The black spruce grows in dense canopies resulting in restricted light penetration to the understorey layer. Mean species richness is 24.4, Shannon diversity is 2.5, and evenness is 0.8. Diversity tends to be lower in this ecosite phase because of the nutrient poor and imperfectly drained nature of soils in this ecosite, and the restricted light levels. One ecosite phase and two plant community types were encountered in the field survey.

g1 black spruce-jack pine/Labrador tea-subhygric

Ecosite phase g1 occupies 15.3% (2,355.7 ha) of the LSA and is dominated by black spruce and jack pine. The dominant understory is Labrador tea and black spruce, with a ground cover of mosses including Schreber's moss and stair-step moss. Organic layer thickness is usually in the 6-15 cm range, but has been found as deep as 80 cm or more. The humus form is mor and raw moder. Soil texture varies greatly by site including, but not limited to, sandy loam, silt, sandy clay loam, silty loam, sand, loamy sand and organic-fibric. Mean species richness is 24.4, Shannon diversity is 2.5, and evenness is 0.8. Five unique species were found in this phase and both plant community types of this ecosite phase were found within the LSA.

g1.1 black spruce-jack pine/Labrador tea/feather moss

g1.2 black spruce-jack pine/feather moss

Labrador tea / horsetail ecosite (h)

Ecosite h is wet and has a medium to rich nutrient regime. It is often found on lower slopes or level areas. Parent material is commonly glaciolacustrine or till. Soils tend to be Gleysolic with an accumulation of organic matter ranging in thickness from 6-60 cm deep. The forest floor is often covered by a blanket of horsetail and Labrador tea. When trees are removed, the water table rises and makes it difficult for trees to re-establish. After disturbance, areas are often colonized by hydrophytic species like willow, marsh reed grass and sedges. Ecosite h is transitional between ecosites g and f, and the moisture regime within the h ecosite can be variable. This provides a gradient of available niches for species establishment which likely contributes to the higher diversity parameters observed in h ecosites. Mean species richness is 29.4, Shannon diversity is 3.2, and evenness is 1.0. One ecosite phase and two plant community types were encountered in the field survey.

h1 white spruce-black spruce/Labrador tea/horsetail

Ecosite phase h1 occupies 0.5% (73.1 ha) of the LSA, and is dominated by white spruce and black spruce with some paper birch. The dominant shrubs, forbs and mosses are Labrador tea, bog cranberry, common and meadow horsetail, stair-step moss and Schreber's moss. The humus form ranges from peaty mor to mor, and mottles are usually visible in the top 25 cm of the soil profile. Soils range from silty loam to clay and organic (mesic and humic) soils. The ground is largely covered in feather moss, Labrador tea and horsetail. The mean species richness is 29.4, Shannon diversity is 3.2, and evenness is 1.0. Four unique plant species were found, and both h1 plant community types were found in the LSA.

h1.1 white spruce-black spruce/Labrador tea/horsetail

h1.2 white spruce-black spruce/Labrador tea/feather moss

Bog ecosite (i)

Ecosite i has mostly organic soil with slowly decomposing peat moss. The sites are poorly drained and have a very-poor to poor nutrient regime. Bogs occupy depressions or level ground where water is stagnant or where there is a high water table impeding drainage and allowing for organic matter accumulation. This ecosite is an "edaphic climax" that is maintained by the water table. Soil texture is fibric, mesic or humic. The organic layer is usually greater than 80 cm thick and the moisture regime is subhydric, hydric or hygric. Oligotrophic species of *Sphagnum* dominate these ecosites contributing to low biodiversity in bog ecosites. The bog ecosite has the lowest diversity measured and this is a reflection of the accumulation of organic matter on poor to very-poorly drained i ecosites (hygric to hydric), and the poor to very-poor nutrient regime found at these sites. Mean species richness is 19.8, Shannon diversity is 2.1 and evenness is 0.7. Two ecosite phase and two plant community types were encountered in the field survey.

i1 treed bog

Ecosite phase i1 occupies 6.5% (1,002.8 ha) of the LSA. It is dominated by stunted black spruce with an understory of Labrador tea, bog cranberry, black spruce and small bog cranberry. There are some forbs present, but ground cover is largely mosses: predominantly peat moss and Schreber's moss. Mean species richness is 19.7, Shannon diversity is 2.4, and evenness is 0.8. Diversity in the i ecosite is low due to the accumulation of organic matter on these poor to very-poorly drained and acidic sites (hygric to hydric), and the poor to very-poor nutrient regime found at these sites Five unique species were observed and one community type was found in the LSA.

i1.1 black spruce/Labrador tea/cloudberry/peat moss

i2 shrubby bog

Ecosite phase i2 was the second most common phase in the LSA, occupying 20.1% (3,090.0 ha). It is typically dominated by shrubs like Labrador tea, black spruce (less than 5 m tall), bog cranberry, leather leaf, small bog cranberry; the forb indicator species cloudberry may also be dominant. Ground cover is predominantly peat moss with some Schreber's moss and/or slender hair-cap moss. Organic thickness is usually greater than 80 cm, but can be in the 60-70 cm range. The humus form is peaty mor. Parent material is organic matter and some organic and glaciolacustrine deposits. Mean species richness is 20.0, Shannon diversity is 1.9, and evenness is 0.6. Five unique species were found in this phase and one community type was observed in the LSA.

i2.1 black spruce-Labrador tea/cloudberry/peat moss

Poor fen ecosite (j)

Ecosite j is wet like a bog, but has more nutrients. The poor fen has an intermediate nutrient regime between the bog and the rich fen. Drainage is poor, but there is some movement of water. Similar to the bog, this ecosite occupies depressions or level areas where organic matter accumulates. The organic matter accumulating in the poor fen consists of bog species and some rich fen species. Organic matter thickness is usually over 80 cm, but occasionally can be significantly less. Soil texture is fibric or mesic, and succession is very slow. The system relies on water flow; impeding the flow could reduce or eliminate tree cover and change species composition. Species richness is 27.0, Shannon diversity is 2.6 and evenness is 0.8. Two ecosite phases and two plant community types were encountered in the field survey.

j1 treed poor fen

Ecosite phase j1 occupied 3.3% (501.9 ha) of the LSA and is dominated by stunted black spruce and tamarack. Both are usually considered unmerchantable. The dominant understory shrubs are Labrador tea, black spruce, bog cranberry, and willow. There are a few more forbs found in this phase than in the i ecosite including common horsetail, three-leaved Solomon's seal and cloudberry. The ground cover is mostly peat moss with some golden moss and other mosses. There are some grasses and lichens present. The mean species richness is 28.2, Shannon diversity was 2.8, and evenness is 0.9. Seven unique species and one community type were observed in the LSA.

j1.1 black spruce-tamarack/dwarf birch/sedge/peat moss

j2 shrubby poor fen

Ecosite phase j2 occupies 8.6% (1,318.1 ha) of the LSA, and is dominated by Labrador tea, black spruce and dwarf birch. There are some forbs, grasses, and lichens. Ground cover is mostly peat moss with some golden moss, tufted moss and slender hair-cap moss. Organic thickness is sometimes less than 80 cm and can range in the 26-39 cm or 60-79 cm range. Soil texture is fibric, mesic, loamy sand, clay, or humic. Occasionally mottles are present in the top 25 cm. Parent material is either organic or, occasionally, morainal till. Mean species richness is 24.8, Shannon diversity is 2.1, and evenness is

0.7. Seven unique species were found in this phase and one community type was observed in the LSA.

j2.1 black spruce-tamarack-dwarf birch/sedge/peat moss

Rich fen ecosite (k)

Ecosite k is an alkaline nutrient rich fen with flowing water contributing nutrients to the system. The topographic position is usually in depressions or level ground where the water table is near the surface for a large part of the growing season. Organic matter is composed of decomposing sedges as well as golden, tufted and brown mosses. Organic thickness is usually greater than 80 cm, but occasionally can be less than 16 cm. Humus form is peatymor. Soil texture is mesic, fibric, clay or heavy clay. Mottles can be found in the top 25 cm in areas without deep organic matter. Succession is slow resulting in slow recovery after disturbance. Species richness is 22.4, Shannon diversity is 2.3, and evenness is 0.7. Lower diversity in this ecosite is not atypical, as rich fens tend to be dominated by a few species of mosses and sedges. Three ecosite phases and six plant community types were encountered in the field survey.

k1 treed rich fen

There are 2.7% (413.8 ha) of treed rich fen in the LSA. This phase is dominated by tamarack with some black spruce. The understory shrub layer is dominated by dwarf birch, tamarack and willow. The understory forb layer is dominated by three-leaved Solomon's seal, buckbean and marsh cinquefoil. There are some grasses and the ground cover is mossy with species like tufted moss, golden moss and peat moss. Organic thickness is greater than 80 cm, the humus form is peaty mor, and the soil texture is fibric or mesic. Mean species richness is 27.7, Shannon diversity is 2.7, and evenness is 0.8. Seven unique species were found in this phase and one community type was observed in the LSA.

k1.1 tamarack/dwarf birch/sedge/golden moss

k2 shrubby rich fen

Ecosite phase k2 occupied 6.1% (930.1 ha) of the LSA, and is dominated by willow species, with some dwarf birch, river alder and tamarack. Typical dominant forbs and grasses are marsh marigold, sweet gale, buckbean, sedge and marsh reed grass. Some mosses are present, specifically brown moss, tufted moss and golden moss. Organic thickness can vary from greater than 80 cm to 0-25 cm. Humus form is peatymor, and soil texture ranges between fibric, mesic, clay, silty loam, humic, heavy clay, and silty clay. Where the organic matter is shallow, mottles have been reported to occur between 0 cm and 25 cm. Parent material is organic, glaciolacustrine or lacustrine. Mean species richness is 21.3, Shannon diversity is 2.3, and evenness is 0.7. There were 17 unique species found in this phase and three community types were found in the LSA.

k2.1 dwarf birch/sedge/golden moss

k2.2 willow/sedge/brown moss

k2.3 willow/marsh reed grass

k3 graminoid rich fen

Ecosite phase k3 occupies 1.4% (211.3 ha) of the LSA and is dominated by sedges, marsh reed grass, and northern reed grass. Forbs and mosses present are marsh cinquefoil, buckbean, marsh skullcap, ragged moss and brown moss. Organic thickness can range between six cm and 80 cm, or more. The humus form is peatymor with a soil texture varying between fibric, heavy clay, mesic, and clay. Where the organic matter is shallow, mottles have been reported to occur between 0 cm and 25 cm. Parent materials are organic, lacustrine, and organic/glaciolacustrine. This phase has the lowest mean species richness in the LSA (13.6), and Shannon diversity and evenness are also low (1.5 and 0. 6, respectively), reflecting the nature of the graminoid fen in which only a few species dominate. Seven unique species were found in this phase and two plant community types were found in the LSA.

k3.1 sedge fen

k3.2 marsh reed grass fen

Marsh ecosite (l)

Ecosite l is very wet (hydric) and rich to very rich in nutrients. Ecosite l is typically found in level or depressed areas and around the shorelines of water bodies and riparian zones. The water is above the rooting zone for part of the growing season. This ecosite is considered a stable community where any changes are determined by disturbance. Organic thickness is less than 15 cm but occasionally can be greater than 80 cm. Humus forms are non-existent, peatymor, or mor. Soil texture varies between sand, organic (fibric), and silty sand. Mottles are observed at depths of 0 - 25 cm. Parent material is lacustrine, fluvial, organic, or organic/lacustrine. Mean Shannon diversity is 2.4 and evenness is 0.7, while mean species richness is 33.7. One ecosite phase and three plant community types were encountered in the field survey.

l1 marsh

Ecosite phase l1 (marsh) occupies 0.04% (6.0 ha) of the LSA. It is dominated by forbs and grasses such as: cattails, northern willow herb, wild mint, sedge, reed grass, marsh reed grass, creeping spike rush, bulrush and rushes. There is often some brown moss present. Mean species richness is 33.7, Shannon diversity is 2.5, and evenness is 0.7. Thirty three unique species, the most of any ecosite phase, were found in this phase. All three plant communities associated with this ecosite phase were found in the LSA.

l1.1 cattail marsh

l1.2 reed grass marsh

l1.3 bulrush marsh

Appendix 4 – Non-native and Invasive Plants observed in the Great Divide SAGD Expansion Project Area

PlotCardLabel	Species	Common Name	Designation	Community	Date	Easting	Northing
74	*Festuca rubra*	red fescue	agro invasive	i2.1	8/30/2006	459311	6212779
15R	*Trifolium hybridum*	alsike clover	agro invasive	k2.3	7/8/2007	454001	6216684
200E	*Glyceria grandis*	common tall manna grass	agro invasive	l1.2	7/6/2007	455957	6221866
200E	*Phleum pratense*	timothy	agro invasive	l1.2	7/6/2007	455957	6221866
200E	*Taraxacum officinale*	common dandelion	nuisance	l1.2	7/6/2007	455957	6221866
200E	*Trifolium hybridum*	alsike clover	agro invasive	l1.2	7/6/2007	455957	6221866
204E	*Chrysanthemum leucanthemum*	ox-eye daisy	noxious	e2.3	7/9/2007	447917	6221884
206SNE	*Cirsium arvense*	creeping thistle	noxious	l1.2	7/10/2007	449397	6222542
206SNE	*Glyceria grandis*	common tall manna grass	agro invasive	l1.2	7/10/2007	449397	6222542
206SNE	*Potentilla norvegica*	rough cinquefoil	nuisance	l1.2	7/10/2007	449397	6222542
206SNE	*Sonchus arvensis*	perennial sow-thistle	noxious	l1.2	7/10/2007	449397	6222542
207SNE	*Glyceria grandis*	common tall manna grass	agro invasive	l1.3	7/11/2007	449024	6217900
207SNE	*Phleum pratense*	timothy	agro invasive	l1.3	7/11/2007	449024	6217900
207SNE	*Trifolium hybridum*	alsike clover	agro invasive	l1.3	7/11/2007	449024	6217900
43R	*Taraxacum officinale*	common dandelion	nuisance	j2.1	7/10/2007	449739	6217897
500NE	*Agropyron pectiniforme*	crested wheat grass	agro invasive	l1.1	7/4/2007	453809	6223394
500NE	*Bromus inermis*	awnless brome	agro invasive	l1.1	7/4/2007	453809	6223394
500NE	*Festuca rubra*	red fescue	agro invasive	l1.1	7/4/2007	453809	6223394
500NE	*Medicago sativa*	alfalfa	agro invasive	l1.1	7/4/2007	453809	6223394
500NE	*Phleum pratense*	timothy	agro invasive	l1.1	7/4/2007	453809	6223394
500NE	*Sonchus arvensis*	perennial sow-thistle	noxious	l1.1	7/4/2007	453809	6223394
500NE	*Taraxacum officinale*	common dandelion	nuisance	l1.1	7/4/2007	453809	6223394
500NE	*Trifolium hybridum*	alsike clover	agro invasive	l1.1	7/4/2007	453809	6223394

PlotCardLabel	Species	Common Name	Designation	Community	Date	Easting	Northing
505NE	*Potentilla norvegica*	rough cinquefoil	nuisance	k3.1	7/6/2007	460113	6214904
508NE	*Glyceria grandis*	common tall manna grass	agro invasive	k2.1	7/7/2007	458402	6215333
509NR	*Potentilla norvegica*	rough cinquefoil	nuisance	k2.2	7/7/2007	460240	6211539
510NE	*Trifolium pratense*	red clover	agro invasive	e1.2	7/9/2007	452580	6223413
912NE	*Melilotus alba*	white sweet-clover	agro invasive	c1.2	7/4/2007	454082	6223423
912NE	*Taraxacum officinale*	common dandelion	nuisance	c1.2	7/4/2007	454082	6223423
912NE	*Trifolium hybridum*	alsike clover	agro invasive	c1.2	7/4/2007	454082	6223423
912NE	*Trifolium pratense*	red clover	agro invasive	c1.2	7/4/2007	454082	6223423
9143SNR	*Potentilla norvegica*	rough cinquefoil	nuisance	k3.1	6/26/2007	456062	6211770
9145NR	*Phleum pratense*	timothy	agro invasive	j2.1	7/6/2007	460036	6214731
9145NR	*Potentilla norvegica*	rough cinquefoil	nuisance	j2.1	7/6/2007	460036	6214731
9145NR	*Trifolium hybridum*	alsike clover	agro invasive	j2.1	7/6/2007	460036	6214731
914SNE	*Taraxacum officinale*	common dandelion	nuisance	f2.1	7/9/2007	450187	6222190
9156NE	*Taraxacum officinale*	common dandelion	nuisance	b2.3	7/7/2007	460161	6211517
933SNR	*Taraxacum officinale*	common dandelion	nuisance	b2.3	7/3/2007	451820	6221252
934SNR	*Taraxacum officinale*	common dandelion	nuisance	b1.3	7/3/2007	450884	6220090
950SNR	*Taraxacum officinale*	common dandelion	nuisance	b1.3	7/10/2007	450930	6221613
962NE	*Erysimum cheiranthoides*	wormseed mustard	nuisance	e1.3	7/8/2007	448159	6223816
962NE	*Potentilla norvegica*	rough cinquefoil	nuisance	e1.3	7/8/2007	448159	6223816
96NE	*Taraxacum officinale*	common dandelion	nuisance	d1.6	7/8/2007	448047	6223964
97NE	*Taraxacum officinale*	common dandelion	nuisance	d1.4	7/9/2007	451502	6223273
97NE	*Trifolium hybridum*	alsike clover	agro invasive	d1.4	7/9/2007	451502	6223273
CO001RL09	*Taraxacum officinale*	Dandelion	nuisance	b1.3	8/6/2009	448345	6219097
CO005RL09	*Taraxacum officinale*	Dandelion	nuisance	d2.0	8/6/2009	451867	6220660
CO005RL09	*Phleum pratense*	Timothy	agro invasive	d2.0	8/6/2009	451867	6220660
CO005RL09	*Trifolium hybridum*	Alsike clover	agro invasive	d2.0	8/6/2009	451867	6220660
CO006RL09	*Phalaris arundinacea*	Reed canary grass	agro invasive	i2.1	8/6/2009	452141	6220658
CO006RL09	*Trifolium hybridum*	Alsike clover	agro invasive	i2.1	8/6/2009	452141	6220658
CO009RL09	*Trifolium hybridum*	Alsike clover	agro invasive	c1.0	8/6/2009	452131	6220275

PlotCardLabel	Species	Common Name	Designation	Community	Date	Easting	Northing
CO011RL09	*Trifolium hybridum*	Alsike clover	agro invasive	c1.1	8/7/2009	451962	6220108
CO012RL09	*Potentilla norvegica*	Rough cinquefoil	nuisance	i1.1	8/7/2009	451606	6220008
CO012RL09	*Taraxacum officinale*	Dandelion	nuisance	i1.1	8/7/2009	451606	6220008
CO012RL09	*Phleum pratense*	Timothy	agro invasive	i1.1	8/7/2009	451606	6220008
CO012RL09	*Trifolium hybridum*	Alsike clover	agro invasive	i1.1	8/7/2009	451606	6220008
CO23RL	*Glyceria grandis*	Great manna grass	agro invasive	k1.1	8/13/2008	453710	6219347
CO25RL	*Taraxacum officinale*	Dandelion	nuisance	b1.1	8/12/2008	452430	6219647
CO25RL	*Trifolium hybridum*	Alsike clover	agro invasive	b1.1	8/12/2008	452430	6219647
CO34RL	*Taraxacum officinale*	Dandelion	nuisance	d1.6	8/12/2008	452436	6220995

Appendix 5 – Traditionally Used Plants and Associated Ecosite Phases observed in the Great Divide SAGD Expansion Project Area

Common Name	Scientific Name	Found in Ecosite Phases in the LSA	Typical Ecosite Phases
aster	*Aster ciliolatus, Aster puniceus*	b1, b2, c1, d1, d2, e1, e2, f2, f3, h1, j1, j2, k2, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
blueberry	*Vaccinium myrtilloides*	b1, b2, c1, d1, d2, d3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, d1, d2, d3
bog birch	*Betula pumila; Betula glandulosa*	b1, c1, g1, h1, i1, i2, j1, j2, k1, k2, k3	g1, h1, i1, i2, j1, j2, k1, k2, k3
bog cranberry	*Vaccinium vitis-idaea, Oxycoccus microcarpus*	b1, b2, c1, d1, d2, d3, e1, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, d1, d2, d3, g1, h1, i1, i2, j1, j2
canadian buffaloberry	*Shepherdia canadensis*	d2	b1, b2, d1, d1, d2, d3
cattail	*Typha latifolia*	k3, l1	k3, l1
chokecherry	*Prunus virginiana*	-	b1, b2, b3, d1, d2
cloudberry	*Rubus chamaemorus*	b1, b2, c1, d3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
currants and gooseberry	*Ribes hudsonianum, Ribes americanum, Ribes triste, Ribes glandulosum, Ribes lacustre, Ribes oxyacanthoides, Ribes hirtellum*	b1, b2, c1, d1, d2, d3, e1, e2, f1, f2, f3, h1, i1, j1, j2, k1, k2, k3, l1	d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1
dwarf rasberry	*Rubus arcticus*	b1, c1 d2, d3, f2, g1, h1, i2, j1, j2, k1, k2, k3, l1	d1 ,d2, d3, e1, e2, e3, f1, f2, f3, g1, h1
fireweed	*Epilobium angustifolium*	b1, b2, c1, d1, d2, d3, e1, e2, f1, f2, f3, g1, h1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, j1, j2, k1, k2, k3, l1
green frog plant / pitcher plant	*Sarracenia purpurea*	.-	i1, i2, j1, j2, k1, k2, k3, l1
harebell / bluebell	*Campanula rotundifolia*	-	d1, d2, d3, e1, e2, e3, f1, f2, f3
hazelnut	*Corylus cornutta*	c1	c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1

Common Name	Scientific Name	Found in Ecosite Phases in the LSA	Typical Ecosite Phases
horsetail	*Equisetum spp.*	b1, b2, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
Labrador tea	*Ledum groenlandicum*	b1, b2, c1, d1, d2, d3, e1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, g1, h1, i1, i2, j1, j2
low-bush cranberry	*Viburnum edule*	b1, b2, c1, d1, d2, d3, e1, e2, f1, f2, f3, h1, j2, k2, l1	d1, d2, d3, e1, e2, e3
mint	*Mentha arvensis*	-	e1, e2, e3, f1, f2, f3, k1, k2, k3, l1
mountain-ash	*Sorbus scopulina*	d3, g1	d1, d2, d3, e1, e2, e3, g1
northern bastard toadflax	*Geocaulon lividum*	c1, d2, h1, j1, j2, k1, k2	c1, d1, d2, d3, e1, e2, e3, g1, h1, i1, i2, j1, j2
paper birch	*Betula papyrifera*	b1, b2, c1, d1, d2, d3, e1, f2, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1	b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
pin cherry	*Prunus pensylvanica*	b1, c1, g1, i2	d1, d2, e1, e2
pink wintergreen	*Pyrola asarifolia*	b1, c1, d1, d2, d3, e1, f2, f3, h1, j1, j2, k1, k2, k3	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, j1, j2, k1, k2, k3
pussy/diamond willow	*Salix discolor, Salix bebbiana*	b1, b2, c1, d1, d2, d3, e1, e2, f2, g1, h1, i1, i2, j1, j2, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, k1, k2, k3, l1
red osier dogwood	*Cornus stolonifera*	e1, f2	e2, e3, f1, f3, k2
reindeer lichen	*Cladina spp.*	b1, b2, c1, d1, d2, d3, e1, d2, f1, f2, f3, g1, h1, i2, j1, j2, k2, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
rose	*Rosa acicularis, Rosa woodsii*	b1, b2, c1, d1, d2, d3, e1, e2, f1, f2, f3, g1, h1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
saskatoon	*Amelanchier alnifolia*	-	b1, b2, b3, b4, d1, d2, e1, e2, e3

Common Name	Scientific Name	Found in Ecosite Phases in the LSA	Typical Ecosite Phases
spiny leaved sow thistle	*Sonchus asper*	-	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
stinging nettle	*Urticoa dioica*	e1, e2, h1, k2, l1	e1, e2, e3, f1, f2, f3, k1, k2, k3, l1
sweet flag/rat root	*Acorus americanus*	-	f1, f2, f3, g1, h1, k1, k2, k3, l1
trailing raspbery	*Rubus pubescens*	b1, c1, d1, d2, d3, e1, e2, f2, f3, h1, j1, k1, k2, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
trembling Aspen	*Populus tremuloides*	b1, b2, c1, d1, d2, d3, e1, f1, f2, f3, g1, h1, i2, j1, j2, k1, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1
valerian	*Valeriana dioica*	-	e1, e2, ,e3, f1, f2, f3, k2, k3
white wintergreen	*Pyrola elliptica*	-	c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, k2, k3, l1
wild chives/wild onion	*Allium schoenoprasum*	-	e1, e2, e3, f1, f2, f3, k1, k2, k3, l1
wild raspberry	*Rubus idaeus*	b1, b2, c1, d1, d2, d3, e1, e2, f1, f2, f3, g1, h1, i2, j1, j2, k1, k2, k3, l1	d1, d2, d3, e1, e2, f1, f2, f3, g1, h1, i2, j1, j2, k1, k2, k3, l1
wild strawberry	*Fragaria virginiana, Fragaria vesca*	c1, d1, d2, e1, f2, f3, h1, j1, k2, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, h1, j1, j2, k1, k2, k3, l1
yarrow	*Achillea millefolium*	c1, d1, d2, d3, e1, e2, f2, h1, j2, k2, k3, l1	a1, b1, b2, b3, b4, c1, d1, d2, d3, e1, e2, e3, f1, f2, f3, g1, h1, i1, i2, j1, j2, k1, k2, k3, l1

Appendix 6 – Description of the AWIS Wetland Types observed in the Great Divide SAGD Expansion Project Area

Bogs

Bogs are characterized by an accumulation of peat (greater than 40 cm) and a surface which is raised above the surrounding groundwater table. Because bogs are not in contact with groundwater, and receive all of their moisture in the form of precipitation, they are quite acidic, with pH ranging from 4.0 to 4.8. This acidity is further perpetuated due to acids produced by peat mosses. Bogs are often treed, with peat moss species and ericaceous shrubs usually present. A surface soil layer and a deep soil layer are present in most bogs. The surface soil layer consists of living plants which decompose and form different peat patterns and landforms. The deeper layer is marked by the lower limit of the water table, and contains peat that is water-logged, and thus poorly oxygenated and not able to decompose (National Wetlands Working Group 1997). Two types of bog are present within the LSA and RSA.

Wooded bog with internal lawns (BTNI)

Wooded bogs with internal lawns (BTNI) were only found in the RSA, outside the LSA. This type of bog typically has open, wet *Sphagnum-Carex* dominated internal lawns, with partially buried stands of dead trees. *Sphagnum angustifolium, S. fallax,* and *S. riparium* are common. Near bog margins, hummocks of *S. fuscum* or *S. magellanicum* often form and support small black spruce trees. Internal lawns are 40 to 60 cm lower than the surrounding wooded bog surface and may occur in irregular patterns radiating from the bog island center, or in nonradiating patterns. Thin seasonal frost layers can last well into late summer. Internal lawns represent pervious areas of permafrost that have become degraded. This type of bog occupies 0.3% (158.4 ha) of the RSA, and the i2 ecosite phase is the closest analogue to this wetland type.

Wooded bogs without internal lawns (BTNN)

The wooded bog is the most common wetland type found in the LSA and RSA. This type of bog occurs on flat surfaces, usually within fen complexes, or in small basins or depressions along drainage divides where there is restricted water flow (Halsey and Vitt 1997). They are wooded (T), with 6-70% tree coverage, usually exclusively consisting of black spruce. In the bogs surveyed within the LSA, small amounts of jack pine were also present; however, it was never the dominant tree species and likely reflects early succession following the 1995 fire. No patterning is present in these bogs (N), as in all bogs, because there is no water flow to create the characteristic ridged pattern, and these bogs are not situated far enough north to be influenced by permafrost. These bogs also did not have internal lawns (N). A description of typical vegetative species on these sites is found in the bog ecosite phase description (Appendix 3). Wooded bogs occupy 26.2% (4092.8 ha) of the LSA, and 26.8% (15391.7 ha) of the RSA.

It should be noted that when classifying wetlands for the Algar project (GDC, 2007a,b), a second type of bog, open with shrub dominant cover, was identified (BONS). However, wetlands of this type are not an allowable classification under AWIS definitions. Often in these open, “shrubby” bogs, the shrub layer is composed of stunted black spruce trees. Under the ecosite classification system (Beckingham and Archibald 1996), ecosites with trees 5 m tall or greater are considered treed, while ecosites with tree species that are less than 5 m tall are classified as shrubby (e.g. treed bog versus shrubby bog). The AWIS classification system does not follow this convention, and considers density of the tree species regardless of height. Since open bogs occur in areas where permafrost is present and tree cover is less than 6%, the initial classification of the BONS wetland type in previous reports was incorrect and should have been BTNN. This has been corrected for this assessment.

Fens

All fens are peatlands (greater than 40 cm of peat accumulation), and differ from bogs in that they have contact with ground and / or surface water, with surface water flow forming channels, pools, or other characteristic patterns. Because they are in contact with water that contains minerals, fens are richer than bogs and support certain species that will only grow on richer sites. These include sedge species, bog birch, golden and brown mosses, and tamarack. Fens can be poor to extreme-rich, with poorer fens being transitional to bogs, and supporting more peat moss species and ericaceous shrubs. The vegetative layer which dominates in the fen is determined by the water table location; drier sites support more tree and shrub species while wetter sites promote the growth of graminoids and bryophytes (NWWG 1997). Five types of fens are present within the LSA and RSA.

Non-patterned, open, graminoid-dominated fens (FONG)

These fens are characterized by less than 6% tree cover and less than 25% shrub cover (O), and sedge and grass species dominate (G). These fens usually occurred as part of peatland complexes, in flat, low-lying areas, sloping gently in the direction of the regional drainage, or adjacent to water bodies. No patterning was present in these fens (N). This type of fen can be poor, moderate-rich, or extreme-rich. In the LSA, they were usually surrounded by treed fens and had a covering of low shrubs throughout. The FONG classification is similar to Beckingham and Archibald's (1996) k3 ecosite phase, and more detailed description of the vegetative species can be found in the sedge rich fen description found in (Appendix 3). Non-patterned, open, graminoid-dominated fens occupy 1.4% (210.5 ha) of the LSA and 2.5% (1426 ha) of the RSA.

Non-patterned, open, shrub-dominated fens (FONS)

These fens have 6% or less tree cover (O), and greater than 25% shrub cover (S). The dominant shrub species are either bog birch or willow species (those growing below shoulder height). These fens are not patterned and usually occur in small basins or flat areas that slope in the direction of drainage. The FONS classification coincides with the j2 and k2 ecosite phases of the Beckingham system, and a detailed description of the vegetation can be found in (Appendix 3). The FONS type of fen occupies 6.0% (928.0 ha) of the LSA and 6.8% (3914.8 ha) of the RSA.

Patterned, open fens with no internal lawns (FOPN)

This type of fen is characterized by open, wet flarks (O)and drier wooded strings and margins that form the characteristic patterning (P) (Halsey and Vitt 1997). In these patterned fens, the wetter flarks dominate, creating an open patterned fen. These are dominated by sedge (*Carex*) species and wetland grasses. The strings are oriented perpendicular to water flow, forming sinuous ribs because of gently sloping terrain (Halsey and Vitt 1997). Because of the distinct patterning, no internal lawns are present (N). Ground cover can be quite diverse, depending on whether the fen is poor, moderate-rich, or extreme-rich. In richer fens, golden moss and brown mosses are common. This type is equivalent to the j2, k2 and k3 ecosite phases in the Beckingham system. Patterned fens do not occur in the LSA, but occupy <0.1% (5.5 ha) of the RSA.

Non-patterned, wooded fens with islands of internal lawns (FTNI)

The FTNI type is characterized by 6-70% tree coverage (T), no patterning (N), and the presence of internal lawns (I). The internal lawns appear as wetter depressions within the wooded fen, having a ground cover containing more hydrophilic species, such as *Sphagnum* or brown moss, compared with the surrounding wooded fen. Dead trees are usually present and tilted in random directions on the lawns, indicating the former existence of permafrost (Halsey and Vitt 1997). This type coincides with the j1 and k1 ecosite phases in the Beckingham system. This wetland type is not present in the LSA, but occupies 0.2% (109.1 ha) of the RSA.

Non-patterned, wooded fens with no internal lawns (FTNN)

The FTNN type has greater than 6 % tree cover of some combination of black spruce and or tamarack (T), sometimes with a shrub understory of bog birch or willow species. If the fen is poor, the ground cover will be dominated by peat moss species, whereas if it is more moderate-rich or extreme-rich, more brown or golden mosses will be present. This fen type has no internal lawns (N) or patterning (N), and is found in flat, low-lying areas. These fen types are typically found in undisturbed areas where moss hummocks have had a chance to build up and form drier microsites which are able to support tree species. The Beckingham system equivalents for the FTNN type are j1 and k1. See (Appendix 3) for a complete description of the vegetation that occurs within these wetland types. The FTNN type is the second most common wetland type observed, and occupies 14.5% (2,234.2 ha) of the LSA and 21.4% (12,278 ha) of the RSA.

Marshes (MONG)

Marshes are open (O), graminoid-dominated wetlands (G) that occur on mineral soil. Characterized by seasonal changes in water level and high volumes of water flow, marshes are largely influenced by ground and surface waters (Halsey and Vitt 1997). Nitrogen and phosphorus concentrations are high, leading to rapid and abundant vascular plant growth. Marshes can be alkaline or saline, and water chemistry greatly influences species composition. This wetland type can be distinguished from other types by their lack of trees or shrubs, and by their association with streams, lakes and shallow open water. Marshes correspond to the l1 ecosite phase, and a description of the vegetation within this type can be found in (Appendix 3). The MONG wetland type is not common in the LSA or RSA, and only occupies <0.1% of the LSA and RSA (6.2 ha and 18.2 ha, respectively).

Swamps

The term swamp is generally applied to forested or wooded wetlands occurring on either organic or mineral soil. Swamps are defined as being dominated by trees or shrubs, usually with greater than 30% cover, and for having wood-rich peat if they occur on organic soils. They are also characterized by their location, which is either near water bodies that flood frequently or along peatlands that have fluctuating water levels (Halsey and Vitt 1997). The water table is usually at, or more frequently below, the ground surface, which allows the shrubs and trees to grow taller than in most fens or bogs.

Both forested swamps (SFNN) and wooded swamps (STNN) were found in the LSA and RSA. Forested swamps have greater than 70% tree coverage (F), and wooded swamps have 6 to 70% tree coverage (T). These swamps usually have a denser and taller tree cover than fens or bogs, because peat depth is less than that found in fens or of a more woody composition, and sites are usually drier. This allows trees to have a greater rooting depth and growth index. The coniferous swamps found in the LSA contained black spruce and were mostly located in narrow bands along streams and adjacent to peatlands. No patterning (N) or internal lawns (N) are present in swamps. The coniferous swamps correspond to the g1 or h1 ecosite phases, and a description of the vegetation within these types can be found in (Appendix 3). The STNN type occupies 0.1% (16.0 ha) of the LSA and 0.1% of the RSA (29.2 ha). The SFNN type occupies 0.6% (91.9 ha) of the LSA and 0.2% (112.0 ha).

Deciduous swamps (SONS)

Deciduous swamps are similar to open shrubby fens but have shrubs that grow, on average, higher than shoulder height. This taller height is reached because woodier or shallower peat is present. These swamps may be dominated by willow species or river alder. The coniferous swamps correspond to the j2 and k2 ecosite phases, and a description of the vegetation within these types can be found in (Appendix 3). The SONS type is not present in the LSA, but occupies 0.4% (225.7 ha) of the RSA.

Flooded areas (NWF)

Flooded areas represent areas which are periodically inundated with water, such as areas flooded by beaver activity. This designation comes from the AVI natural cover types that have <6% plant cover, and is not part of the AWIS classification. When possible, ecosite phase and AWIS classification of these areas is completed. If classification through site visits and aerial photo interpretation could not be completed, the AVI classification was maintained. These sites occupy <0.1% of the LSA and RSA (4.9 ha and 12.6 ha, respectively).

Ponds and Lakes (NWL)

Ponds and lakes do not have wetland or ecosite classifications, and so the AVI classification was maintained (NWL). However, riparian and wetland communities along the margins of ponds and lakes were delineated and classified to ecosite phase and AWIS type (i.e. l1/MONG, k3/FONG). The NWL sites occupy 0.5% (75.4 ha) of the LSA and 0.4% (226.7 ha) of the RSA.

Appendix 7 – ANHIC Query Results for the Great Divide SAGD Expansion Project Regional Study Area

Element Occurrence ID	UTM Zone	Easting	Northing	Element Occurrence Number	Tracked	Provincial Rank	Species	Common name	Survey date
16241	12	449743.8	6220008.8	16	Y	S2	Scapania paludicola	liverwort	8/11/2006
15767	12	448723.9	6219282.5	2	Y	S1	Lophozia rutheana	liverwort	6/15/2005
15764	12	449027.9	6219324	8	Y	S2	Bryum cyclophyllum	moss	6/14/2005
15763	12	448215.9	6218712.5	19	Y	S2	Sphagnum fallax	peat moss	6/14/2005
15767	12	448723.9	6219282.5	2	Y	S1	Lophozia rutheana	liverwort	6/15/2005
15770	12	448477.9	6218880.9	10	Y	S2	Riccardia latifrons	liverwort	6/15/2005
15776	12	448340.9	6218613	6	Y	S3	Chrysosplenium iowense	golden saxifrage	6/10/2005
15776	12	448340.9	6218613	6	Y	S3	Chrysosplenium iowense	golden saxifrage	6/10/2005
15763	12	448215.9	6218712.5	19	Y	S2	Sphagnum fallax	peat moss	6/14/2005

Appendix 8 – Rare Plant Species observed in the Great Divide Expansion Project Area

The key number indicates the corresponding location of each species plotted on the rare plant figure (Figure 5-6).

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
1	961NE	460459	6211020	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	b2.3
1	961NE	460459	6211020	*Lecidea leprarioides*	lichen				b2.3
1	961NE	460459	6211020	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	b2.3
1	961NE	460459	6211020	*Splachnum vasculosum*	large-fruited splachnum	S2	Track	G3G5	b2.3
2	9156NE	460161	6211517	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	b2.3
2	9156NE	460161	6211517	*Xylographa parallela*	black woodscript lichen	S2	Track	G5	b2.3
3	509NR	460240	6211539	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k2.2
3	509NR	460240	6211539	*Omphalina umbellifera*	lichen	S1	Track	GNR	k2.2
4	CLADC4	460477	6211577	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	g1.2
5	9110NR	460607	6211618	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
6	9139SNR	455536	6211630	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i2.1
6	9139SNR	455536	6211630	*Omphalina umbellifera*	lichen	S1	Track	GNR	i2.1
7	9138SNR	455925	6211716	*Trapeliopsis viridescens*	lichen				c1.1
8	9143SNR	456062	6211770	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k3.1
9	70	457486	6211771	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
9	70SR	457469	6211786	*Cladonia albonigra*	sordid pixie cup				j1.1
10	9141SNR	456007	6211785	*Cladonia grayi*		S2	Track	GU	k1.1
10	9141SNR	456007	6211785	*Cladonia norvegica*		S1	Track	G4G5	k1.1
11	203EF	458799	6211812	*Biatora crysantha*	lichen				d3.4
11	203SE	458799	6211807	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	d3.4
12	9137SNR	455902	6211813	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	j2.2
12	9137SNR	455902	6211813	*Cladonia merochlorophaea*		S2	Track	GU	j2.2
13	9140SNR	455971	6211886	*Lecanora boligera*	lichen				k2.1

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
14	58R	460572	6211887	*Arthonia patellulata*	aspen comma	S3?	Track	G5	k2.3
15	930SE	458706	6211953	*Cladonia merochlorophaea*		S2	Track	GU	d2.3
16	9112SNOR	458448	6211975	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i2.1
17	73E	458405	6212090	*Riccardia multifida*	liverwort	S2S3	Track	G5	i1.1
18	60SE	459835	6212315	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	g1.2
19	57E	460786	6212459	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	j1.1
20	62SE	459580	6212791	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	c1.1
20	62SE	459580	6212791	*Splachnum rubrum*	red collar moss	S3	Track	G3	c1.1
21	53	460486	6213237	*Cephalozia bicuspidata*	liverwort	S1	Track	G5	k3.1
22	300	457949	6213420	*Lophozia heterocolpos*	liverwort	S2	Track	G5	k2.1
22	300	457949	6213420	*Sarmenthypnum sarmentosum*	lichen	S2	Track	G4G5	k2.1
23	63SE	460096	6213512	*Splachnum rubrum*	red collar moss	S3	Track	G3	h1.1
24	65SR	460743	6213573	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
25	69SE	457492	6213646	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	g1.1
25	69SE	457492	6213646	*Lecanora densa*	lichen				g1.1
26	303SR	458111	6214215	*Lophozia excisa*	liverwort	S1	Track	G5	i1.1
26	303SR	458111	6214215	*Splachnum ampullaceum*	flagon-fruited splachnum	S2	Track	G5	i1.1
27	9144NR	461039	6214330	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
27	9144NR	461039	6214330	*Cladonia cyanipes*		S2	Track	GNR	i1.1
27	9144NR	461039	6214330	*Cladonia merochlorophaea*		S2	Track	GU	i1.1
27	9144NR	461039	6214330	*Omphalina umbellifera*	lichen	S1	Track	GNR	i1.1
28	CLADC1	461117	6214522	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
29	503NR	460893	6214621	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	j1.1
29	503NR	460893	6214621	*Cladonia albonigra*	sordid pixie cup				j1.1
29	503NR	460893	6214621	*Potamogeton foliosus*	leafy pondweed	S2	Track	G5	j1.1

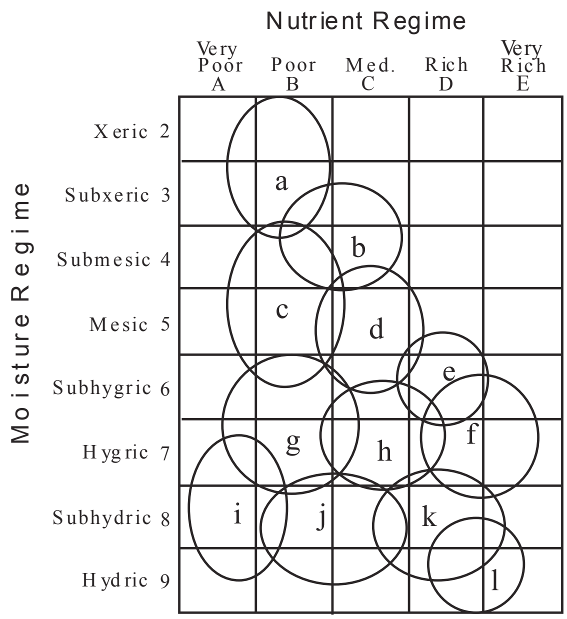
Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
30	9145NR	460036	6214731	*Omphalina umbellifera*	lichen	S1	Track	GNR	j2.1
31	508NE	458402	6215333	*Carex vesicaria*	blister sedge	S1	Track	G5	k2.1
31	508NE	458402	6215333	*Micarea denigrata*	lichen	S1	Track	G2G4	k2.1
31	508NE	458402	6215333	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	k2.1
31	508NE	458402	6215333	*Xylographa trunciseda*	lichen				k2.1
32	9150NR	456113	6215624	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	g1.1
32	9150NR	456113	6215624	*Cladonia cyanipes*		S2	Track	GNR	g1.1
32	9150NR	456113	6215624	*Cladonia umbricola*		S1	Track	G3G5	g1.1
33	9151NR	456119	6215678	*Omphalina umbellifera*	lichen	S1	Track	GNR	i2.1
34	507NE	459800	6215722	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	k1.1
34	507NE	459800	6215722	*Cladonia grayi*		S2	Track	GU	k1.1
34	507NE	459800	6215722	*Lophozia excisa*	liverwort	S1	Track	G5	k1.1
35	947NE	456541	6215846	*Cladonia grayi*		S2	Track	GU	g1.1
36	501NR	456806	6215860	*Cladonia bacilliformis*	yellow tiny toothpick cladonia	S2S3	Track	G4G5	j2.1
37	9153NR	456672	6215893	*Biatora pullata*	lichen				j1.1
37	9153NR	456672	6215893	*Lecanora hybocarpa*	lichen	S1	Track	G5	j1.1
37	9153NR	456672	6215893	*Lophozia excisa*	liverwort	S1	Track	G5	j1.1
37	9153NR	456672	6215893	*Omphalina umbellifera*	lichen	S1	Track	GNR	j1.1
37	9153NR	456672	6215893	*Scapania cuspiduligera*	liverwort	S2	Track	G5	j1.1
38	9152NR	456753	6215913	*Cladonia cyanipes*		S2	Track	GNR	j2.1
39	49R	452435	6216570	*Omphalina umbellifera*	lichen	S1	Track	GNR	g1.1
40	27SE	450174	6216613	*Cladonia bacilliformis*	yellow tiny toothpick cladonia	S2S3	Track	G4G5	i2.1
41	15R	454001	6216684	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	k2.3
41	15R	454001	6216684	*Lecanora albella*	lichen				k2.3
41	15R	454001	6216684	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	k2.3
42	22R	452678	6216906	*Omphalina umbellifera*	lichen	S1	Track	GNR	i2.1
43	48R	453187	6216923	*Omphalina umbellifera*	lichen	S1	Track	GNR	i2.1
44	948NE	450358	6217227	*Cladonia merochlorophaea*		S2	Track	GU	h1.1

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
44	948NE	450358	6217227	*Mycobilimbia hypnorum*	lichen	S1	Track	GNR	h1.1
44	948NE	450358	6217227	*Omphalina umbellifera*	lichen	S1	Track	GNR	h1.1
44	948NE	450358	6217227	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	h1.1
45	CHRYC4	449327	6217263	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k1.1
46	29SE	448109	6217321	*Arthonia patellulata*	aspen comma	S3?	Track	G5	k2.3
46	29SE	448109	6217321	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k2.3
47	958NR	449308	6217409	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k2.2
47	958NR	449308	6217409	*Omphalina umbellifera*	lichen	S1	Track	GNR	k2.2
47	958NR	449308	6217409	*Orthotrichum affine*	lichen	SU	Track	G3G5	k2.2
48	CO09RL	453810	6217839	*Peltigera conspersa*	lichen				c11
48	CO09RL	453810	6217839	*Placynthiella uliginosa*	lichen	S2	Track	G5	c1.1
49	19SE	453160	6217895	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	j1.1
50	43R	449739	6217897	*Cladonia merochlorophaea*		S2	Track	GU	j2.1
51	207SNE	449024	6217900	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	l1.3
52	33SR	449008	6217955	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	k2.3
53	926NE	457130	6217978	*Nephroma bellum*	lichen	S2	Track	G3G5	b1.3
54	20SR	452882	6218070	*Splachnum ampullaceum*	flagon-fruited splachnum	S2	Track	G5	k3.1
54	20SR	452882	6218070	*Splachnum luteum*	yellow collar moss	S3	Track	G3	k3.1
54	20SR	452882	6218070	*Splachnum rubrum*	red collar moss	S3	Track	G3	k3.1
55	16SE	452116	6218275	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	j2.1
56	CO024RL09	455989	6218365	*Cephaloziella hampeana*	liverwort	S1	Track	G5	c1.1
57	305R	453195	6218367	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	i1.1
57	305R	453195	6218367	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
58	922NR	457299	6218389	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	j1.1
59	36R	450937	6218594	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	j1.1
60	46SE	453821	6218698	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	i1.1
60	46SE	453821	6218698	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
60	46SE	453821	6218698	*Pseudevernia consocians*	lichen	S1	Track	G3G5	i1.1

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
61	CO11RL	453400	6218795	*Cladonia grayi*		S2	Track	GU	c1.1
62	CO027RL09	454083	6218848	*Cladonia rei*		S2	Track	G3G5	i2.1
63	511NE	449722	6219062	*Rinodina orculata*	lichen				f2.1
64	CO24RL	452628	6219149	*Lecidea leprarioides*	lichen				i11
64	CO24RL	452628	6219149	*Pycnora leucococca*	lichen				i11
65	CO41RL	448828	6219236	*Cladonia cyanipes*		S2	Track	GNR	i2.1
66	DROSC1	452768	6219332	*Drosera linearis*	slender-leaved sundew	S2	Track	G5/T5	i2.1
66	DROSC1	452768	6219332	*Juncus stygius var americanus*	marsh rush	S2	Track	G5T5	i2.1
67	CO017RL09	453917	6219335	*Pseudobryum cinclidioides*	moss	S2	Track	G5	k1.1
68	CO23RL	453710	6219347	*Lecanora boligera*	lichen				k11
68	CO23RL	453710	6219347	*Lecidea leprarioides*	lichen				k11
68	CO23RL	453710	6219347	*Xylographa parallela*	black woodscript lichen	S2	Track	G5	k1.1
69	919NR	457876	6219572	*Cladonia merochlorophaea*		S2	Track	GU	j1.1
70	CO21RL	453679	6219611	*Splachnum luteum*	yellow collar moss	S3	Track	G3	c1.1
71	CO25RL	452430	6219647	*Cladonia grayi*		S2	Track	GU	b1.1
72	CO099RL09	455869	6219757	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
73	924NR	455647	6219900	*Cladonia bacilliformis*	yellow tiny toothpick cladonia	S2S3	Track	G4G5	j1.1
73	924NR	455647	6219900	*Cladonia merochlorophaea*		S2	Track	GU	j1.1
74	CO012RL09	451606	6220008	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
75	996NR	455989	6220013	*Biatora albohyalina*	lichen				i1.1
75	996NR	455989	6220013	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	i1.1
75	996NR	455989	6220013	*Omphalina umbellifera*	lichen	S1	Track	GNR	i1.1
76	92NSE	451159	6220167	*Biatora efflorescens*	lichen				d1.8
76	92NSE	451159	6220167	*Biatora pallens*	lichen				d1.8
77	CO31RL	452677	6220254	*Micarea denigrata*	lichen	S1	Track	G2G4	c1.1
77	CO31RL	452677	6220254	*Xylographa parallela*	black woodscript lichen	S2	Track	G5	c1.1
78	CO30RL	452247	6220275	*Cladina stygia*	(black-based) reindeer	S1	Track	G5	c1.1

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
					lichen				
79	CO29RL	451770	6220338	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	g1.1
80	CO007RL09	452223	6220431	*Pseudobryum cinclidioides*	moss	S2	Track	G5	i1.1
81	201E	455656	6220890	*Micarea misella*	lichen				k2.2
82	953SNR	451524	6220952	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	e1.3
83	992SNE	455690	6221060	*Cladonia grayi*		S2	Track	GU	c1.1
84	202E	456158	6221133	*Lecidea leprarioides*	lichen				i1.1
84	202E	456158	6221133	*Lophozia excisa*	liverwort	S1	Track	G5	i1.1
85	9103NE	455836	6221248	*Cladina stygia*	(black-based) reindeer lichen	S1	Track	G5	i1.1
85	9103NE	455836	6221248	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	i1.1
86	933SNR	451820	6221252	*Cladonia bacilliformis*	yellow tiny toothpick cladonia	S2S3	Track	G4G5	b2.3
86	933SNR	451820	6221252	*Cladonia merochlorophaea*		S2	Track	GU	b2.3
86	933SNR	451820	6221252	*Orthotrichum affine*	lichen	SU	Track	G3G5	b2.3
87	960SNE	447555	6221734	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	f1.1
87	960SNE	447555	6221734	*Lophozia excisa*	liverwort	S1	Track	G5	f1.1
88	3	457728	6221820	*Cephaloziella hampeana*	liverwort	S1	Track	G5	k3.2
89	204E	447917	6221884	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	e2.3
89	204E	447917	6221884	*Conocephalum conicum*	snake liverwort	S2	Track	G5	e2.3
90	9136NR	455913	6221921	*Cladonia norvegica*		S1	Track	G4G5	b1.3
91	205SNE	450265	6221932	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	f3.1
91	205SNE	450265	6221932	*Splachnum luteum*	yellow collar moss	S3	Track	G3	f3.1
92	98SNE	449347	6222519	*Leskeella nervosa*	lichen	S2	Track	G5	d1.5
92	98SNE	449347	6222519	*Mycobilimbia hypnorum*	lichen	S1	Track	GNR	d1.5
92	98SNE	449347	6222519	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	d1.5
93	206SNE	449397	6222542	*Carex scoparia*	broom sedge	S1	Track	G5	l1.2
93	206SNE	449397	6222542	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	l1.2
94	SPLALUT	456083	6222573	*Splachnum ampullaceum*	flagon-fruited splachnum	S2	Track	G5	j2.1
94	SPLALUT	456083	6222573	*Splachnum luteum*	yellow collar moss	S3	Track	G3	j2.1

Key	PlotCardLabel	Easting	Northing	Species	Common name	Provincial Rank	Tracked	Global Rank	Community
95	13R	455960	6222582	*Lophozia excisa*	liverwort	S1	Track	G5	j2.1
96	1SE	456689	6223267	*Bryoria simplicior*	simple horsehair	S2S3	Track	G3G5	k2.1
96	1SE	456689	6223267	*Lecanora boligera*	lichen				k2.1
97	510NE	452580	6223413	*Leskeella nervosa*	lichen	S2	Track	G5	e1.2
97	510NE	452580	6223413	*Nephroma bellum*	lichen	S2	Track	G3G5	e1.2
97	510NE	452580	6223413	*Ramalina dilacerata*	punctured gristle	S2	Track	G3G5	e1.2
98	912NE	454082	6223423	*Arthonia patellulata*	aspen comma	S3?	Track	G5	c1.2
99	928SE	456286	6223530	*Chiloscyphus pallescens*	liverwort	S1	Track	G5	i2.1
99	928SE	456286	6223530	*Lophozia incisa*	liverwort	S2	Track	G5	i2.1
100	937NE	451279	6223546	*Arthonia patellulata*	aspen comma	S3?	Track	G5	d1.4
101	9104SE	455733	6223644	*Xylographa parallela*	black woodscript lichen	S2	Track	G5	b1.3
102	962NE	448159	6223816	*Chrysosplenium iowense*	golden saxifrage	S3?	Track	G3?	e1.3
102	962NE	448159	6223816	*Conocephalum conicum*	snake liverwort	S2	Track	G5	e1.3
102	962NE	448159	6223816	*Hygroamblystegium tenax*		S2	Track	G5	e1.3
102	962NE	448159	6223816	*Lecanora albella*	lichen				e1.3
103	910NE	451315	6223825	*Arthonia patellulata*	aspen comma	S3?	Track	G5	d2.4
104	915SNE	452508	6223833	*Cladonia merochlorophaea*		S2	Track	GU	h1.1



Ecosites:

a = lichen
subxeric/poor

b = blueberry
submesic/medium

c = Labrador tea–mesic
mesic/poor

d = low-bush cranberry
mesic/medium

e = dogwood
subhygric/rich

f = horsetail
hygric/rich

g = Labrador tea–subhygric
subhygric/poor

h = Labrador tea/horsetail
hygric/medium

i = bog
subhydric/very poor

j = poor fen
subhydric/medium

k = rich fen
subhydric/rich

l = marsh
hydric/rich

Figure 3-1. Edatope (moisture/nutrient grid) showing the location of ecosites for the Boreal Mixedwood ecological area (Beckingham and Archibald 1996).

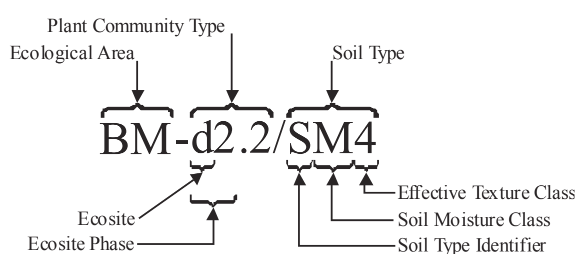


Figure 3-2. Example of an ecological unit identification code for the hierarchical ecological classification system (Beckingham and Archibald 1996).

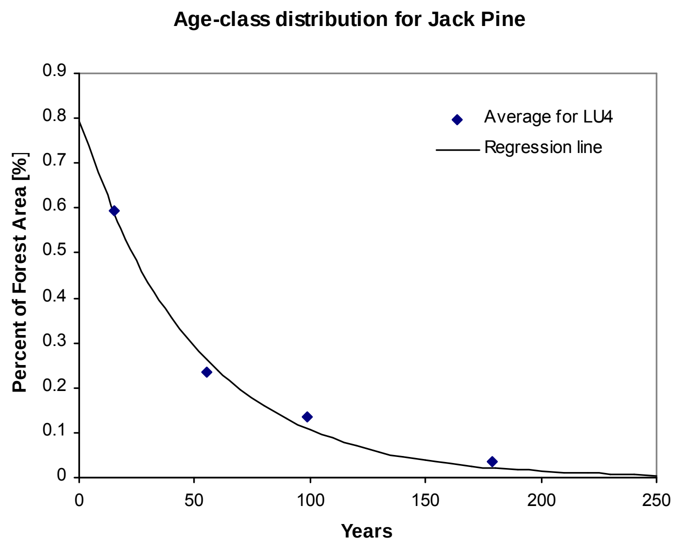


Figure 4-2. Age-class distribution for Jack pine with a 49.8 years fire rotation shown as a proportion of the entire forested area of LU 4.

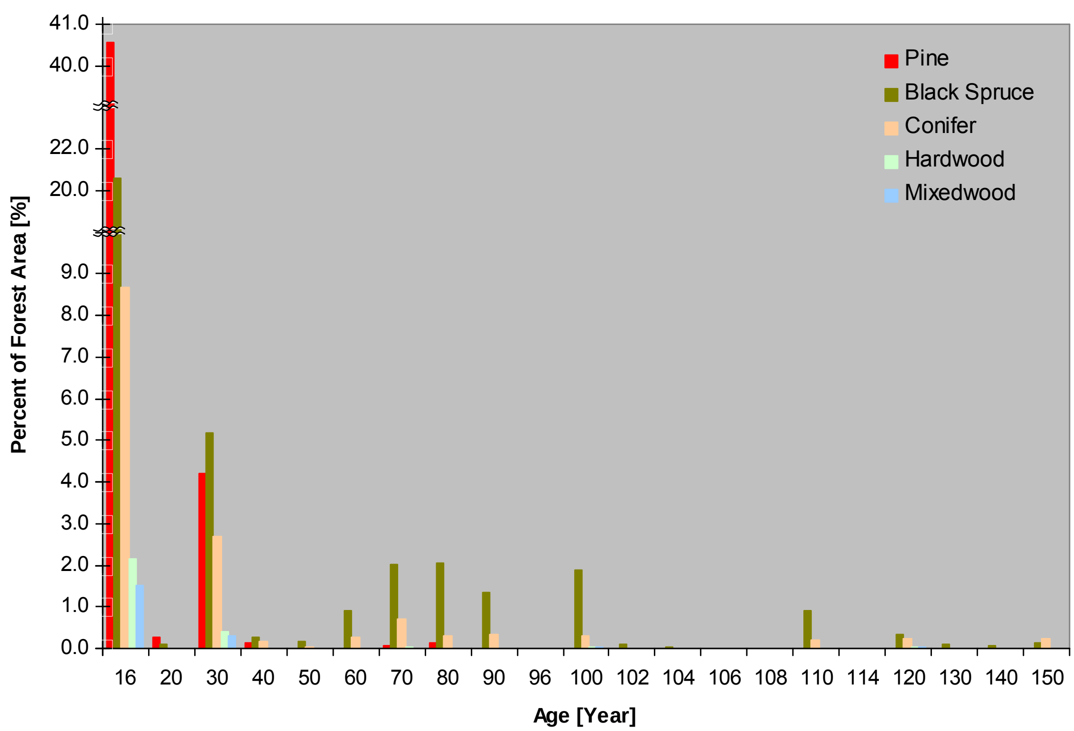


Figure 5-3. Proportion of Forest Types by Age (2-year Intervals) within the RSA

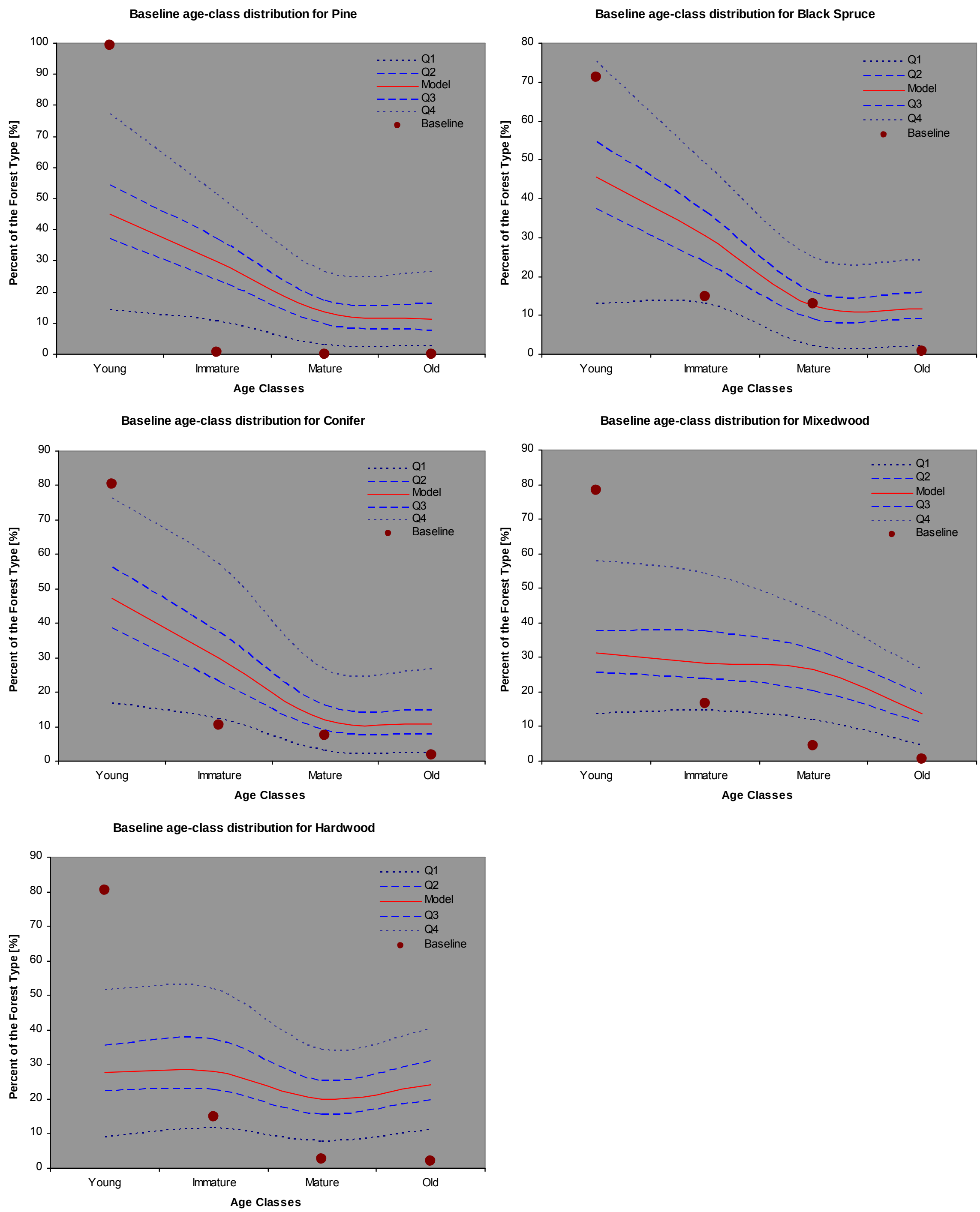


Figure 5-4. Baseline Age-Class Distributions by Forest Type in RSA. Shown is the current condition (baseline) relative to the expected distribution for each forest type. The natural range of variation for Landscape Unit 4 is shown as quartiles.

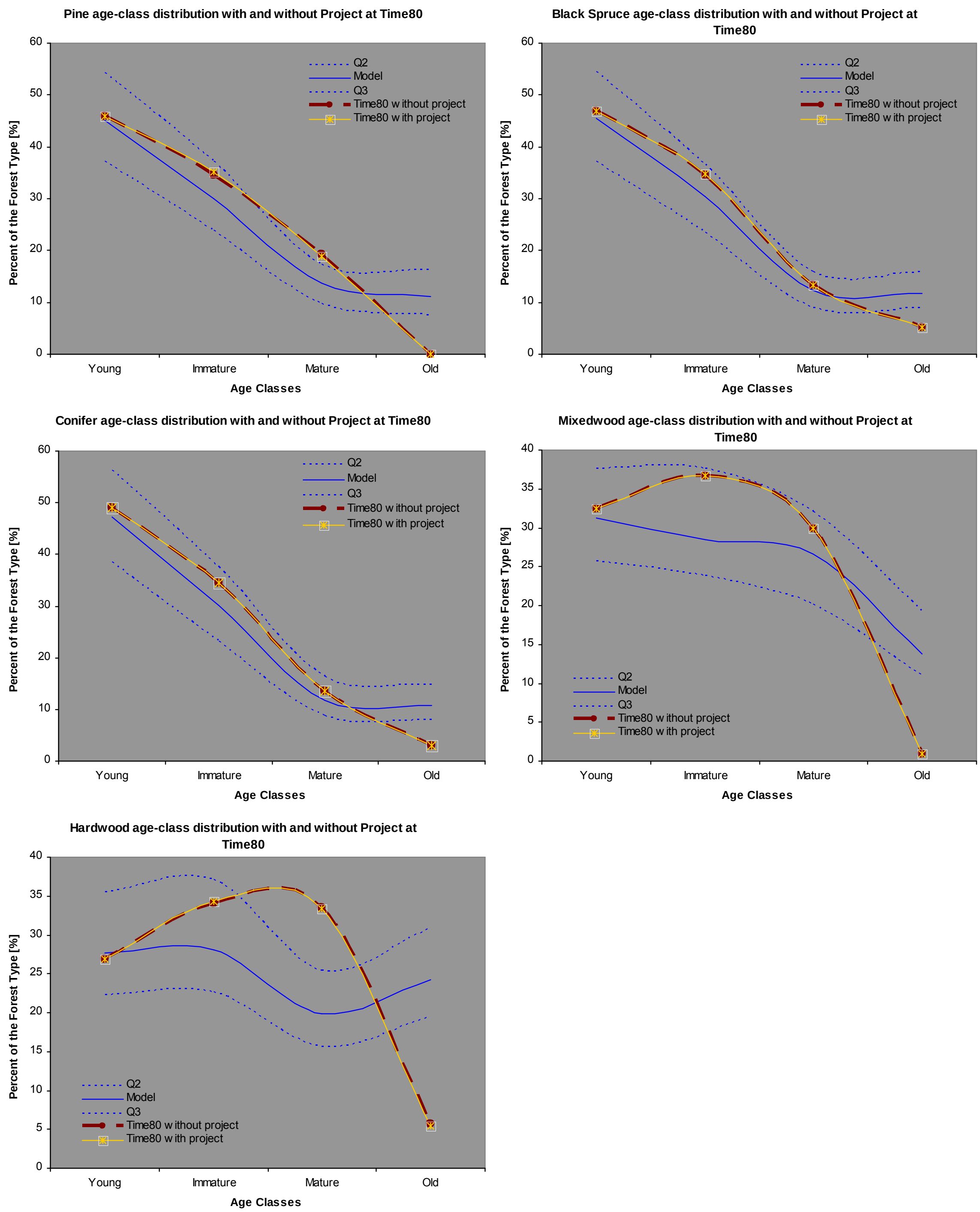


Figure 6-1. Predicted Age-Class Distributions by Forest Type in RSA at Time80.