TransCanada
In business to deliver

450 - 1 Street SW
Calgary, Alberta T2P 5H1

Tel: (403) 920-5892
Fax: (403) 920-2347
Email: trishna_wirk@transcanada.com

August 18, 2015

Filed Electronically

National Energy Board
517 Tenth Avenue SW
Calgary, Alberta T2R 0A8

Attention: Ms. Sheri Young, Secretary of the Board

Dear Ms. Young:

Re: NOVA Gas Transmission Ltd. (NGTL)
Liege Lateral Loop 2 (Thornbury Section) and
Leismer East Compressor Station (Project)
Condition 6 – Preliminary Caribou Habitat Restoration Plan (CHRP)
NEB File: OF-Fac-Gas-N081-2014-11 01
Order XG-N081-003-2015 (Order)
Submission of Revised Preliminary CHRP

Enclosed is a further revised Preliminary CHRP for the Project. On July 17, 2015, the Board issued a letter (NEB Filing ID: A71316) approving the Preliminary CHRP filed June 30, 2015 (NEB Filing ID: A71014), but directed NGTL to address in the Final CHRP five concerns noted in the July 17 letter. As NGTL is committed to continuous improvement, NGTL has proactively revised the Preliminary CHRP for the Project to address the Board's ongoing feedback and to incorporate recent lessons learned from implementing CHRP measures for the Chinchaga Lateral Loop No. 3 (Chinchaga Project).

In particular, NGTL has revised the Preliminary CHRP to address the Board's concerns, as follows:

- In point #1, the Board directed NGTL to include the area of operational access as a spatial residual effect. NGTL has enhanced the language in Section 5.2 of the Preliminary CHRP to clearly articulate spatial residual effects in both the long term and short term as they relate to operational access.
- In point #2, the Board directed NGTL to clearly define how baseline data on access control will be determined and provide defensible justification for this. NGTL has added Section 5.4.1 to clearly articulate how baseline data on access control will be determined.
- In points #3 and #4, the Board directed NGTL to incorporate 200 m or 400 m line-of-sight distances as quantifiable targets. The Board also directed NGTL to either meet the Alberta Energy Regulator Enhanced Approval Process (EAP) or explain why it is not meeting the EAP for the quantifiable target, given that both NGTL's decision framework and the

provincial EAP specify shorter distances. Recent lessons learned from implementing CHRP measures for the Chinchaga Project have demonstrated that implementing line-of-sight blocks at these distances is not feasible. Therefore, it is likely that the related quantifiable targets would be unattainable. NGTL has, therefore, substantially revised the decision framework figures in Section 3 to incorporate recent experience gained from the Chinchaga Project. Figure 3-2 of the decision framework now clearly prescribes 500 m intervals, which is consistent with the language in Table 4-1. Section 5.5 and Section 6.3 have also been modified to explain why NGTL will not be implementing sightline distances less than 500 m, as in the EAP.

- In point #5, the Board directed NGTL to develop immediate/short-term quantifiable targets, and reminded NGTL that any temporal lags need to be factored into the calculations for its offset measures. NGTL considers the "short term" to mean equal to or less than five years and that "immediate" in this context would occur as soon as line of sight blocking measures have been constructed. For measures that are immediately effective for line-of-sight blocking, such as those identified in Section 2 and Section 5, no quantifiable targets have been assigned to those measures. NGTL feels it is premature to identify short term targets without a scientific basis or baseline data to justify those targets, which currently do not exist. NGTL will implement short term quantifiable targets when more field and/or industry data become available through NGTL's own experience, industry practice or research to support such targets. NGTL has added Section 5.7 to the Preliminary CHRP to provide an explanation and illustrative example of the quantitative framework that will be used to assess habitat restoration effectiveness.

For comparison purposes, NGTL has enclosed as Appendix F a blacklined comparison of the version of the Preliminary CHRP filed June 30, 2015.

If the Board requires additional information with respect to this filing, please contact me by phone at (403) 920-5892 or by email at trishna_wirk@transcanada.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Trishna Wirk
Regulatory Project Manager
Regulatory Services

Enclosures

cc: Paul Gregoire, Wildlife Biologist, Environment Canada
Joann Skilnick, Senior Wildlife Biologist, Alberta Environment and Sustainable Resource Development
Ed Barnett, Forest Officer, Regional Approvals, Alberta Environment and Sustainable Resource Development
Grant Chapman, Senior Wildlife Biologist, Alberta Environment and Sustainable Resource Development

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION AND ORGANIZATION

1.1 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada PipeLines Limited (TransCanada), received National Energy Board (NEB or Board) Order XG-N081-003-2015 approval on January 28, 2015 under section 58 of the *National Energy Board Act* (NEB Act) for authorization to construct and operate Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station (the Project). For the Project regional location, see Figure 1-1. This Preliminary Caribou Habitat Restoration Plan (CHRP) was prepared for the Project pursuant to NEB Order XG-N081-003-2015 Condition 6 and outlines NGTL's plan to avoid impacts, minimize Project effects on caribou and restore caribou habitat. This document also incorporates feedback received from applicable regulators and technical experts, lessons learned from field experience, industry experience and updated results from ongoing literature review.

The goal of both the Preliminary and Final CHRP will be to minimize "residual effects" of the Project on caribou habitat. Residual effects are environmental effects predicted to remain after mitigation is applied. Tailored to site-specific conditions, mitigation measures related to the disturbance of caribou habitat will be implemented on the Project footprint throughout the pre-construction, construction and post-construction phases of the Project.

The Final CHRP will supplement this Preliminary CHRP by detailing the location and type of restoration that is planned along the Project right-of-way (ROW), and by predicting residual effects requiring caribou habitat offsetting measures. Residual effects presented in the Final CHRP will consider lag time and factor in uncertainty associated with offsets. The approach to validate residual effects predictions (direct and indirect) and restoration success is described in this CHRP, with the detailed adaptive management plan to be described in the Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP). The Final CHRP will be filed on or before November 1 after the first complete growing season following the project being placed into service.

In addition to the CHRP and CHROMMP, NGTL will develop an Offset Measures Plan (OMP) to address Project residual effects on caribou habitat pursuant to Condition 7. The Preliminary OMP will be filed with the NEB at least 90 days before requesting leave to open the Project. The Preliminary OMP will further detail the method used to quantify the offsets.

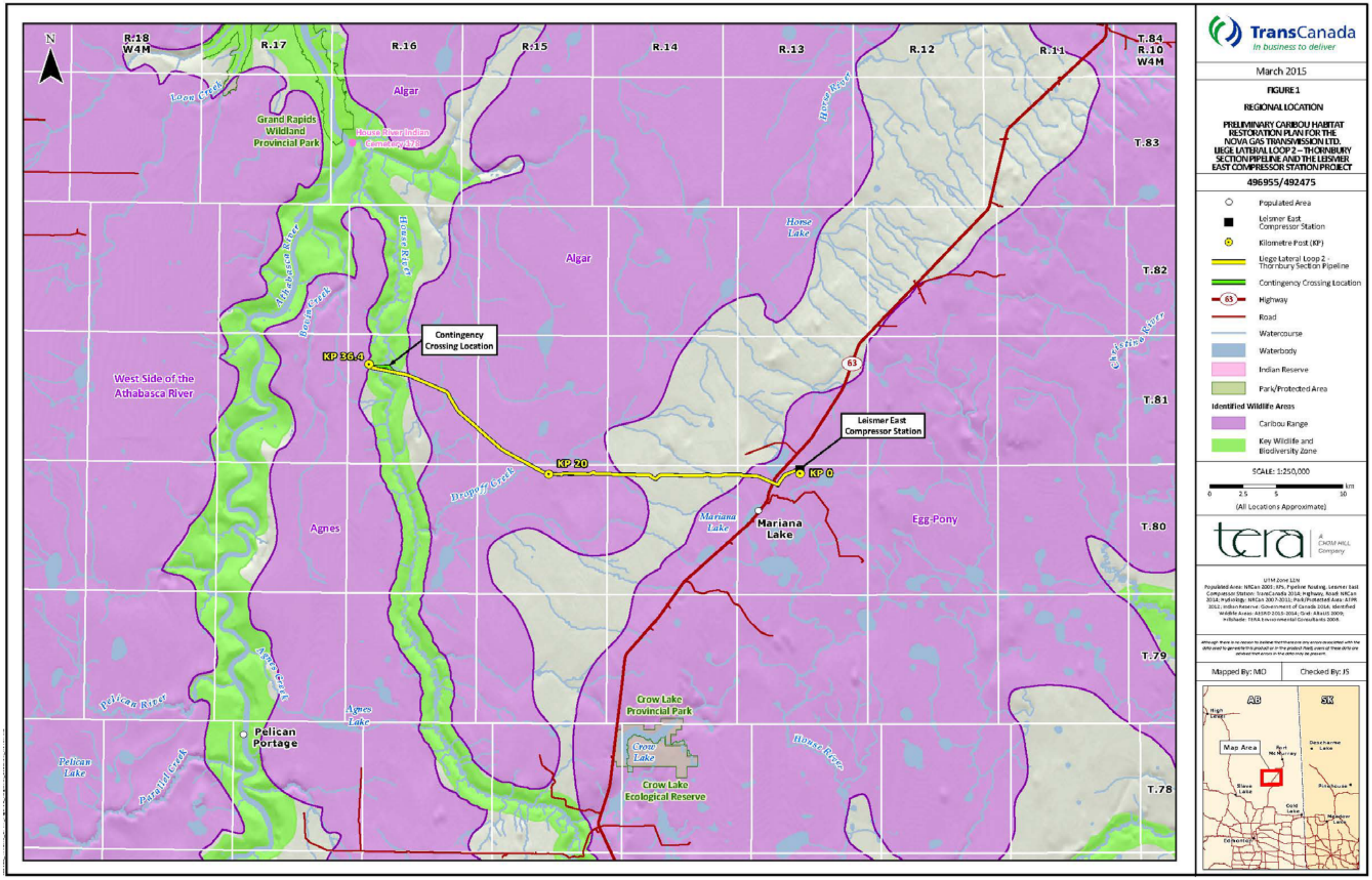


Figure 1-1: Regional Location

1.2 ORGANIZATION OF THE PRELIMINARY CHRP

This Preliminary CHRP is organized in eight sections, as follows:

Section 2: introduces the goal, objectives and quantifiable targets.

Section 3: introduces the habitat restoration decision framework used to prioritize potential caribou habitat restoration sites and to prioritize mitigative actions to be used in different site types, considering typical site factors that could constrain implementation.

Section 4: outlines quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects, the extent to which the goals and objectives have been met, and the need for consequent compensation offsets.

Section 5: describes the CHRP, which includes a description of how the spatial disturbance will be calculated (as the calculation will not be completed until the final CHRP is prepared), habitat restoration, further monitoring details, adaptive management and the implementation schedule.

Section 6: describes how field innovations and experience have been incorporated.

Section 7: provides a summary of caribou-specific consultation with federal and provincial regulators to date, as well as a summary of how feedback was incorporated in the Preliminary CHRP. NGTL will continue to maintain open communication with federal and provincial regulatory agencies, as well as potentially affected communities, through the various Project phases. The Final CHRP will include updated consultation records.

Section 8: is a literature review, on which the decision framework for this document is based, that includes:

- identification of temporal and spatial caribou habitat restoration methods applicable to woodland caribou
- assessment of the relative effectiveness of the identified methods
- description of the literature review approach

The Preliminary CHRP is organized to address each requirement of Order-XG-N081-003-2015 Condition 6. For the locations in this document that outline how each condition has been met, see Table 1-1.

Table 1-1: NEB ORDER-XG-N081-003-2015 – Condition 6: Caribou Restoration Plan

NEB ORDER-XG-N081-003-2015 Conditions	Details and Location in Report
6. Caribou Habitat Restoration Plan (CHRP) NGTL shall file with the Board, for approval, preliminary and final versions of a CHRP for the Project, and shall provide a copy of each version to Environment Canada and Alberta Environment and Sustainable Resource Development (AESRD) at the time of filing with the Board. The CHRP shall comprise:	
a) A preliminary CHRP to be filed at least 90 days prior to commencement of construction, to include but not be limited to: i) the goals and measurable objectives of the CHRP;	Section 2 of the Preliminary CHRP introduces the goal, objectives and quantifiable targets.
ii) the decision frameworks that will be used to prioritize potential caribou habitat restoration sites and to prioritize mitigative actions to be used at different types of sites, including consideration of typical site factors that may constrain implementation;	Section 3 provides a decision framework.
iii) a review of literature upon which the decision frameworks are based including: i. an identification of temporal and spatial caribou habitat restoration methodologies applicable to woodland caribou; ii. an assessment of the relative effectiveness of the identified methodologies; iii. detailed methodology of how the literature review was conducted.	Section 8 of the Preliminary CHRP summarizes relevant literature and describes the method for the literature review.
iv) the quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects, the extent to which the goals and objectives have been met, and the need for consequent compensation offsets;	Section 2 and Section 4 of the Preliminary CHRP describe quantitative criteria to evaluate effectiveness, and include a brief description of monitoring and adaptive management measures. Further information on monitoring and offsets will be provided in the OMP and CHROMMP under separate cover in accordance with Order Conditions 7 and 8.
v) a schedule indicating when measures will be initiated and completed;	Section 5.6 of the Preliminary CHRP provides the schedule for construction and habitat restoration activities.
vi) evidence and a summary of consultation feedback with Environment Canada and AESRD regarding the CHRP; and	Section 7 of the Preliminary CHRP summarizes consultation and feedback on the CHRP from Environment Canada (EC) and AESRD.
vii) evidence and a summary of how consultation feedback with Environment Canada and AESRD is integrated into the CHRP.	Section 7 of the Preliminary CHRP summarizes consultation and feedback on the CHRP from EC and AESRD.

Table 1-1: NEB ORDER-XG-N081-003-2015 – Condition 6: Caribou Restoration Plan (cont'd)

NEB ORDER-XG-N081-003-2015 Conditions	Details and Location in Report
b) A final CHRP to be filed on or before 1 November after the first complete growing season following the commencement of operation of the Project, to include but not be limited to: i) the preliminary CHRP, with any updates identified in a revision log that includes the rationale for any changes to decision making criteria; ii) a table describing caribou habitat restoration sites, including but not limited to location, spatial area, description of habitat quality, site-specific restoration activities and challenges; iii) specification drawings for the implementation of each restoration method; iv) maps or Environmental Alignment Sheets showing the locations of the sites; v) evidence and a summary of how further consultation feedback from Environment Canada and AESRD is integrated into the plan; and vi) a quantitative and qualitative assessment of the total area of direct disturbance to caribou habitat that will be restored, the duration of spatial disturbance, and the aerial extent of the resulting residual effects to be offset, which also includes indirect disturbance.	The Final CHRP will be filed on or before November 1, 2016. For schedule information, see Section 5.6.

2.0 GOAL, OBJECTIVES AND QUANTIFIABLE TARGETS

This section describes the goal, objectives and quantifiable targets of the CHRP.

2.1 GOAL

The overarching goal of NGTL's caribou habitat restoration plan is to minimize the predicted residual effects of the Project and the Project's contribution to cumulative effects on caribou and caribou habitat in a manner that aligns with provincial and federal policies.

2.2 OBJECTIVES

The objectives of the CHRP were designed to achieve the goal in a way that incorporates the best information available, and can be implemented and can be measured to quantify residual effects on caribou and impacted caribou habitat. The three objectives of the CHRP are:

1. **Habitat restoration**: revegetation of the Project footprint that achieves establishment, survival and growth of target species in the short term, so natural ecosystems, consistent with adjacent ecosystems, are expected to regenerate over the long term. For example, caribou habitat will be restored in the Project footprint through revegetation, mounding, bioengineering and berms to provide both immediate and sustainable functional habitat that supports caribou recovery over the long term.
2. **Access control**: effectively discourages access in the Project footprint as an interim measure until results of the monitoring program indicate long-term habitat restoration has been successful. For example, access and use of the ROW is controlled through placement of coarse woody debris, tree felling, sign placement, and rollback to limit access.
3. **Line-of-sight blocking**: reduce lines-of-sight along the Project footprint using barriers such as screens and vegetation. For example, tree planting, tree felling, vegetative and fabricated site screening are intended to reduce visibility along the ROW.

The CHRP goal to minimize Project residual effects on impacted caribou habitat will be attained by implementing the three objectives identified above. The Final CHRP will assess the objectives from a qualitative and quantitative perspective.

2.3 QUANTIFIABLE TARGETS

Quantifiable targets are the criteria that will be used to determine whether the CHRP objectives identified in Section 2.2 have been achieved:

- extent of predicted residual effects
- whether the CHRP objectives have been achieved
- need for compensation offsets

For more information on quantifiable targets and performance measures, see Section 4.

3.0 DECISION FRAMEWORK

The decision framework (see Figures 3-1, 3-2 and 3-3) will be used to guide the Project in meeting the goal of the CHRP. The decision framework NGTL has developed is a principle based logic model that supports each of the three objectives and forms the basis for quantifiable targets.

The decision framework was initially developed by NGTL from information obtained in the literature review, as well as industry best management practices and industry consultation. However, the decision framework included in this CHRP has been revised to reflect recent lessons learned from field experience on other NGTL projects that impact caribou habitat. In particular, the decision framework has been revised to incorporate lessons learned in implementing line of sight blocks and access control measures on the Chinchaga Project.

The decision framework will be applied at the start of construction to identify candidate sites for mitigation measures and reviewed during construction to identify any changes in inputs. Mitigation will be applied during final cleanup.

Figures 3-1, 3-2 and 3-3 are presented in chronological order of which they are implemented: access control, line of sight blocking and habitat restoration. These figures show restoration measures or tools that can be applied to the Project footprint in order to meet the CHRP goal. However, only tools applicable to the Project, as restoration measures, will be applied. These are outlined in Section 5, Table 5 3.

Key factors in the choice of these restoration measures or tools include:

- natural site characteristics
- existing disturbance and activities
- regulatory requirements
- site-specific construction methods

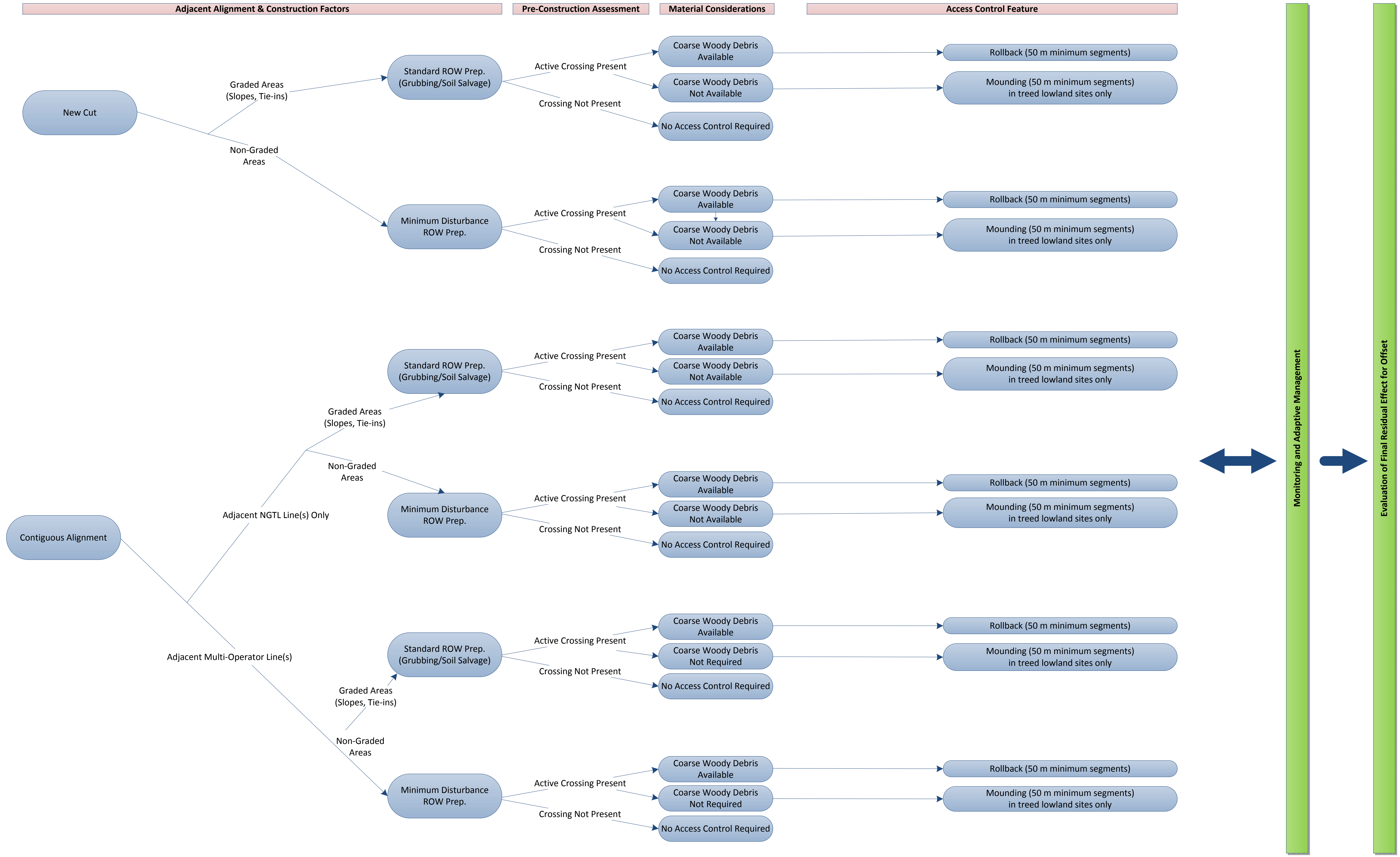
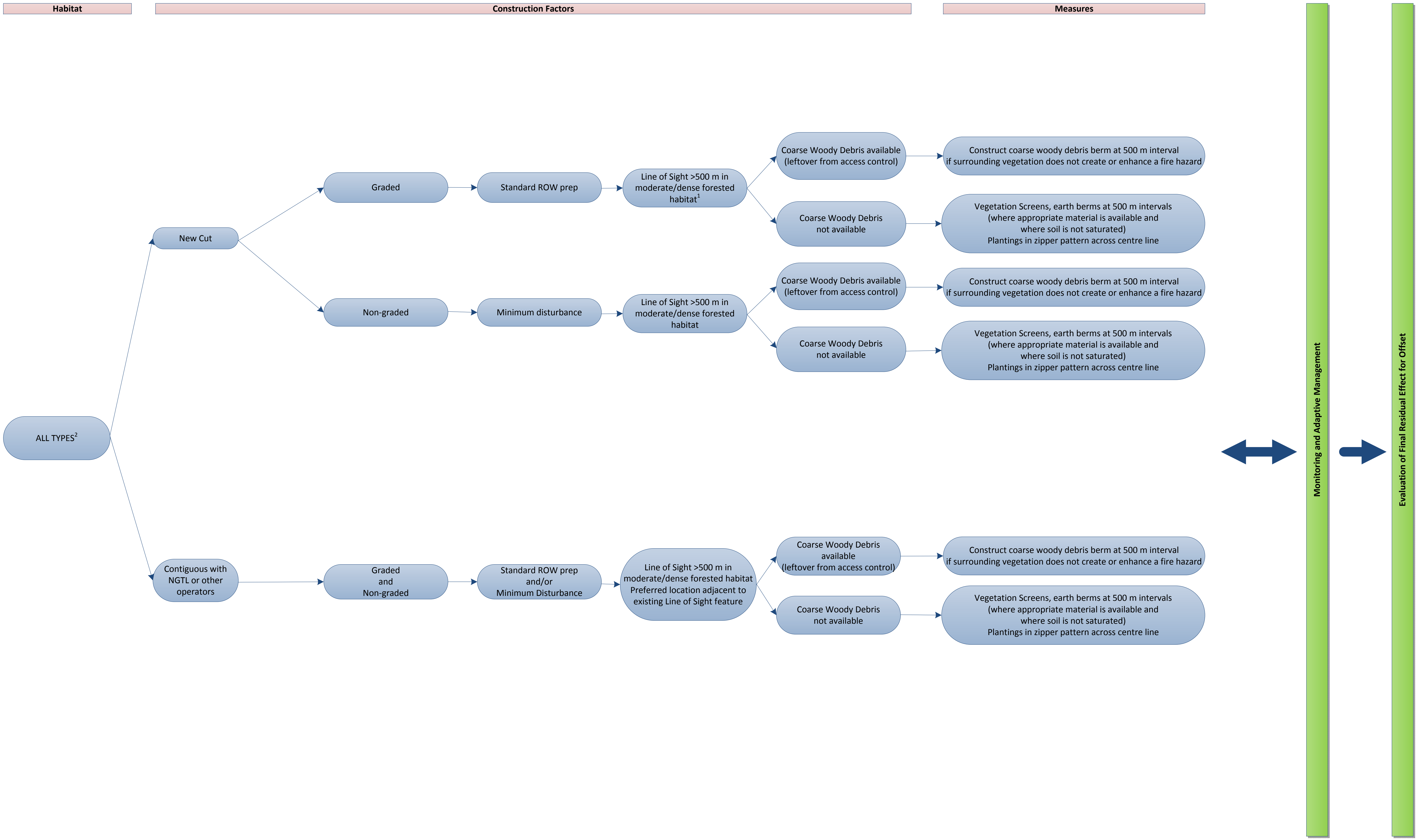


Figure 3-1 Access Control Decision Framework



Note: (1) Line of Sight breaks will not be implemented in open habitat where line of sight naturally exists. See Section 5.
(2) Wetland or open habitats will be evaluated on a case-by-case basis (see Table 4-1).

Figure 3-2 Line of Sight Decision Framework

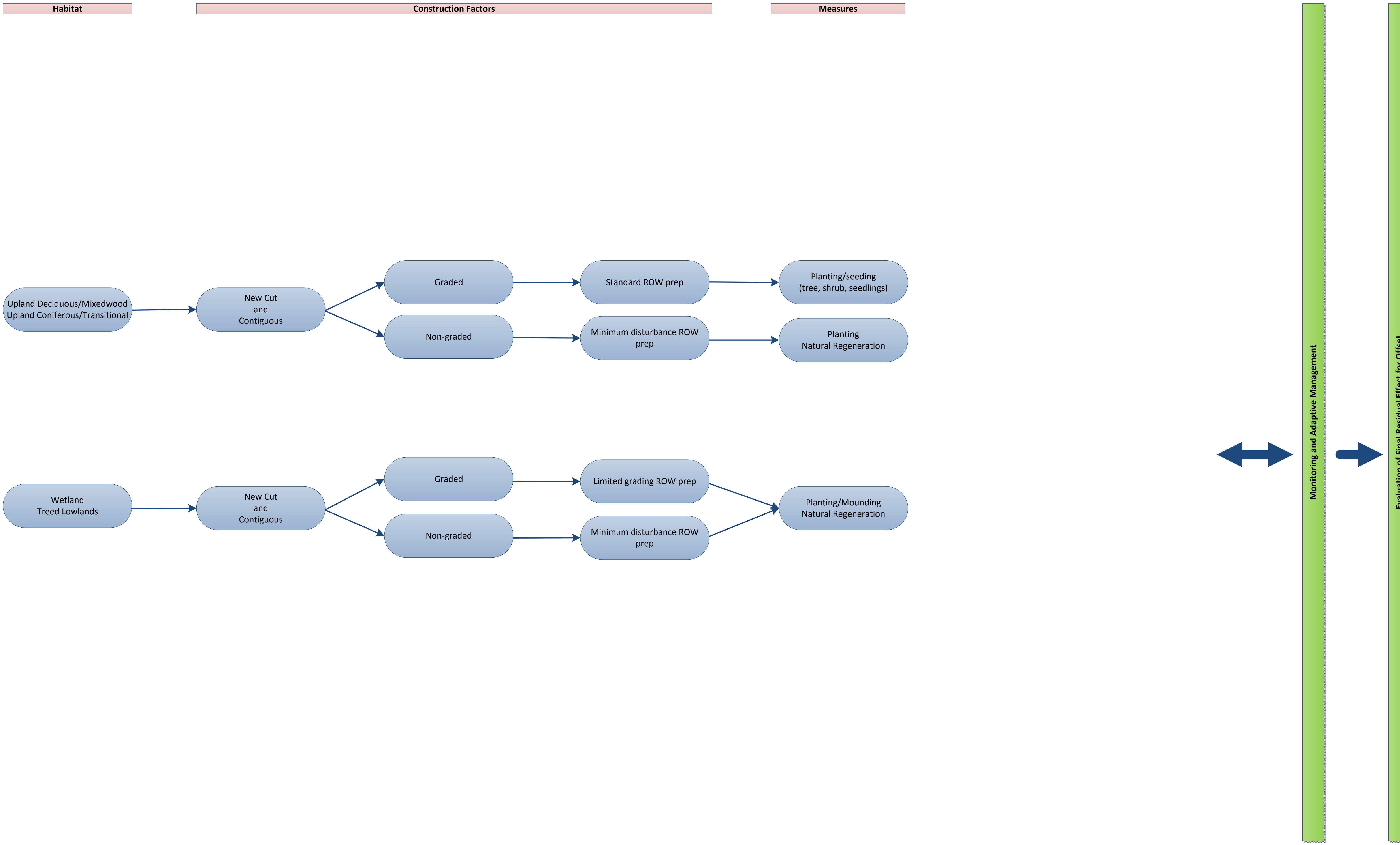


Figure 3-3 Habitat Restoration Decision Framework

4.0 QUANTIFIABLE TARGETS AND PERFORMANCE MEASURES

This section describes:

- quantifiable targets and performance measures used to evaluate the extent of predicted residual effects
- the extent to which CHRP goal and objectives have been met
- the need for compensation offsets for any residual effects remaining after implementation of CHRP measures

For a summary of the quantifiable targets and performance measures available to the Project, see Table 4-1. The quantifiable targets and performance measures selected for the Project work in conjunction with the decision framework described in Section 3.

Table 4-1: Quantifiable Targets and Performance Measures

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Habitat Restoration	• Successful native vegetation re-establishment using the proposed habitat restoration measures will achieve trajectories toward natural ecosystem types, which will eventually re-establish native wildlife habitat. • The Project footprint in caribou range is the proposed clearing of new area (i.e., excludes overlapping/shared areas with existing disturbances). • NGTL's operation and maintenance practice includes vegetation control over the pipe centreline (approximately 6–10 m wide area centred over the pipeline) as a corporate mechanism to meet compliance with CSA-Z662-15. This Standard requires that vegetation is controlled along rights-of-way to maintain clear visibility from the air and provide ready access for maintenance crews (CSA 2015). Although there is flexibility in NGTL's vegetation control practice to allow for wildlife habitat objectives yet remain in compliance with CSA Z662-15, NGTL acknowledges limitations for sustained revegetation success along the pipe centreline while the pipeline is in operation. NGTL understands its obligations for achieving equivalent land capability at end of pipeline life.	Upland Deciduous/Mixedwood/Transitional • Achieve >80% or higher survival rate for planted seedlings within 15 years following implementation of CHRP measures. • Demonstrate sustained growth trends across >80% of restoration locations within 15 years following implementation of CHRP measures. Upland Coniferous • Achieve >80% or higher survival rate for planted seedlings within 15 years following implementation of CHRP measures. • Demonstrate sustained vegetation growth trends across >80% of restoration locations within 15 years following implementation of CHRP measures.	• Quantitative measures of success will include comparisons of regeneration parameters (e.g., vigour, height, percent cover, species composition) between Years 1, 3, 5, 10, 15 following start of operation, with the objective of ensuring establishment of each habitat type and a trend toward achieving equivalent land capacity. If regeneration parameters are not met, adaptive management measures will be implemented to meet vegetation reestablishment trajectory. It is intended that plantings will be monitored for 15 years. • GPS location, number and type of restoration treatments and the frequency of monitoring sessions will be defined and mapped in the final CHRP.

Table 4-2: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Habitat Restoration (cont'd)	• Areas of the Project footprint that parallel existing footprints with grass cover could have limited successful survival of planted species, due to competition from species ingress from adjacent disturbance. • Overlapping dispositions such as a gravel roads or facilities could limit long-term restoration success.	Wetlands/Treed Lowlands • Achieve ≥50% survival rate for planted seedlings/transplants within 15 years following implementation of CHRP measures. • Demonstrate sustained growth trends across ≥50% of restoration locations within 15 years following implementation of CHRP measures.	• Where revegetation success is inadequate, NGTL will determine an appropriate adaptive management. For example, if seedling mortality is unexpectedly high, NGTL will do additional planting, improve site conditions for seedling success or improve restoration efforts at other sites.

Access Control	• Access control measures are most effective when implemented at intersections of the Project ROW with existing perpendicular linear features (e.g., roads, utility corridors, seismic lines).
	• Access by NGTL staff and contractors, including operations personnel as well as reclamation and monitoring crews, will be recorded and monitored. Access by Project personnel within the footprint in caribou range will be limited to the extent practical.
	• Traditional access might need to be maintained.
		Access Control:
		The following quantifiable targets will be used to measure the access control objective:
		• a lower measure (e.g., rate, proportion, count) of access along the segments of the Project right-of-way where access is controlled relative to uncontrolled segments
		• <20% increase in access (e.g., rate, proportion, count) from the baseline assessment as measured by remote cameras
		• The quantifiable targets for access in the Project ROW are expected to be achieved within 5 years following CHRP implementation, though monitoring will continue over 15 years.
			• Evidence and level of access along Project ROW using criteria ratings such as:
			  ◦ access evident: Yes/No
			  ◦ access type: ATV/ truck/ snowmobile/ non-motorized/
			  ◦ predator/ other
			• Access level: low (tracks/ trail evident but difficult to discern or appears to be infrequently used)/high (tracks/trails appear to be well-used; vegetation is trampled down, bare ground from frequent use might be visible). Access level definitions will be refined in the final CHRP.
			An evaluation of whether the objective for access control is achieved will consider recorded evidence of qualitative and quantitative data.

Table 4-3: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Line-of-Sight Blocking	• There is no direct provincial regulation in Alberta for line-of-sight management for linear features. Reclamation programs for previous developments in Alberta have targeted maximum sightlines of 400 m (Golder 2007; DES 2004). Operating practices for energy development in sensitive caribou range in BC (BC Ministry of Environment 2011) suggest implementing line-of-sight management every 500 m on linear features that do not share a ROW boundary with a road. • Bends in the pipeline (doglegs) can reduce line-of-sight, but opportunities to do this for the Project might be limited where it parallels other ROWs. • Wetlands and some treed lowlands encountered by the Project footprint naturally have low and/or open vegetation structure. The line-of-sight distance in these areas is naturally long and, therefore, sightline management techniques are not practical for these locations. • Concern from provincial regulators regarding fire hazard and forest health (pathogen spread), availability of material, suitability of substrate to support structures (i.e., peat does not support fencing), introduction of weeds from imported material and potential for alteration in surface hydrology (particularly from earth berms) can limit applicability of this treatment type.	Line-of-Sight Blocking: • Along the Project ROW, in areas of new cut or contiguous Project ROW with NGTL lines only, achieve sightline distance of < 500 m within 15 years following implementation of CHRP measures. • Along the Project ROW, in areas of new cut or contiguous Project ROW with NGTL lines only, where planting for future vegetation screens in combination with or without rollback have been installed, achieve 80% or higher survival rate for planted seedlings that are intended as line-of-sight blocks within 15 years following implementation of CHRP measures. • Where existing linear features intersect the Project ROW (i.e., seismic and other utility ROWs), achieve line-of-sight block distances equal to or less than pre-construction distances.	Establish line-of-sight blocks in forested areas of the footprint in caribou range that will achieve a sightline distance of 500 m or less in areas of new cut or in sections contiguous with, and adjacent to, NGTL lines only.

Table 4-4: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Line-of-Sight Blocking (cont'd)	• Appropriate locations for line-of-sight blocks will be identified post-construction when final clearing is complete. • A combination of measures, including vegetation screening, rollback and mounding will be applied. Feasibility of installing berms or fencing will be investigated post-construction. • Fewer limitations are associated with using vegetation screening to reduce line-of-sight. • Paralleling an existing linear corridor presents challenges for line-of-sight blocking where the adjacent line is owned by a different company. Application of sightline management techniques should extend across the width of the Project footprint and adjacent disturbance to be effective.		

Notes:

[1] Restoration objectives will continue to be evaluated for the Final CHRP to consider any updated consultation with Alberta Environment and Sustainable Resource (AESRD) now referred to as Alberta Environment and Parks [AEP] or other information that becomes available.

Available footprint is the area of the Project footprint that is not anticipated to be disturbed by future operation and maintenance activities during the life of the Project.

5.0 THE RESTORATION IMPLEMENTATION PLAN

This section provides a high-level summary of Project impacts to affected boreal woodland caribou habitat. This section also describes NGTL's plan to implement a decision framework (see Section 3) which will be used by the Project to achieve the overarching goal of the CHRP. The content of this section presents NGTL's plan to reduce residual and cumulative effects of the Project on caribou and impacted caribou habitat.

5.1 PROJECT IMPACTS TO CARIBOU HABITAT

The Environmental and Socio-Economic Assessment (ESA) for the Project identified potential direct and indirect effects of the Project on boreal woodland caribou and boreal woodland caribou habitat through changes in habitat conditions, herd movement and caribou mortality risk. The cumulative effects analysis completed as part of the ESA determined that the Project will result in an incremental contribution to the overall cumulative effects on the Egg–Pony and Algar herds of the East Side Athabasca River (ESAR) caribou range. Baseline conditions identified in the ESA will be used to determine the level of vegetation restoration required.

The Project linear disturbance presented inTable 5-1 reflects the most recent Project design at the time this Preliminary CHRP was prepared. The pipeline route is located in the Egg–Pony caribou range for approximately 4.9 km, of which 3.1 km (64%) parallels existing pipeline ROWs. The entire length is in an area of historical forest fire that occurred in 1981. The pipeline route is located in the Algar caribou range for approximately 18.9 km, and parallels an existing pipeline, road or seismic line for the entire length. In the Algar caribou range, approximately 12.2 km (65%) of the pipeline route is in an area of historical forest fire that occurred in 1995 and the House River fire that occurred in 2002 (see Figure 5-1). The ROW width will vary based on the workspace and will be reported in the final CHRP.

Table 5-1: Caribou Ranges that Interact with the Project

Caribou Range	Alberta Provincial and Federal Status Designation	Current Population Trend	Caribou Herd	Project Linear Disturbance in Caribou Range (km)					
				Total Length	Parallels Existing Road	Parallels Existing Pipeline	Parallels Existing Seismic Lines	Parallels Linear Disturbance	New Linear Disturbance
ESAR	Threatened[1,2,3]	Declining[4]	Egg–Pony	4.9 km	–	3.1 km (64%)	0.1 km (3%)	3.3 km (67%)	1.6 km (33%)
			Algar	18.9 km	1.3 km (7%)	13.4 km (71%)	4.21 km (22%)	18.9 km (100%)	0 km (0%)

Note:
1 Alberta provincial status designation under the *Wildlife Act* (AESRD 2014a).
2 Status designation under Schedule 1 of the *Species at Risk Act* (SARA) (Environment Canada 2015).
3 Status designation by COSEWIC 2015.
4 Population trend reported by Environment Canada 2012.

5.2 QUANTIFICATION OF HABITAT DISTURBANCE

Restoration of disturbed habitat assumes that caribou will return to spatial separation from primary prey (moose and deer) and predators and, as a result, return to pre-disturbance levels of mortality risk (Athabasca Landscape Team 2009). Restoration of anthropogenic disturbances is also expected to reduce the degradation of functional habitat for caribou, since caribou will no longer exhibit reduced use on or near (i.e., in a zone of influence) the reclaimed disturbance (Oberg 2001). As such, restoration of caribou habitat is expected to alleviate the residual direct habitat disturbance over the long term.

By addressing residual direct habitat disturbance, indirect residual effects will also be addressed. Included in the direct disturbance footprint are the ROW,temporary workspace, compressor station site and new permanent access (see Figure 5-2). The Final CHRP will provide schematics that illustrate the quantification of direct and indirect residual effects of the Project on caribou habitat using as-built information. Indirect disturbance (i.e., reduced habitat effectiveness) is defined as the area within the 500 m buffer of anthropogenic disturbance features.

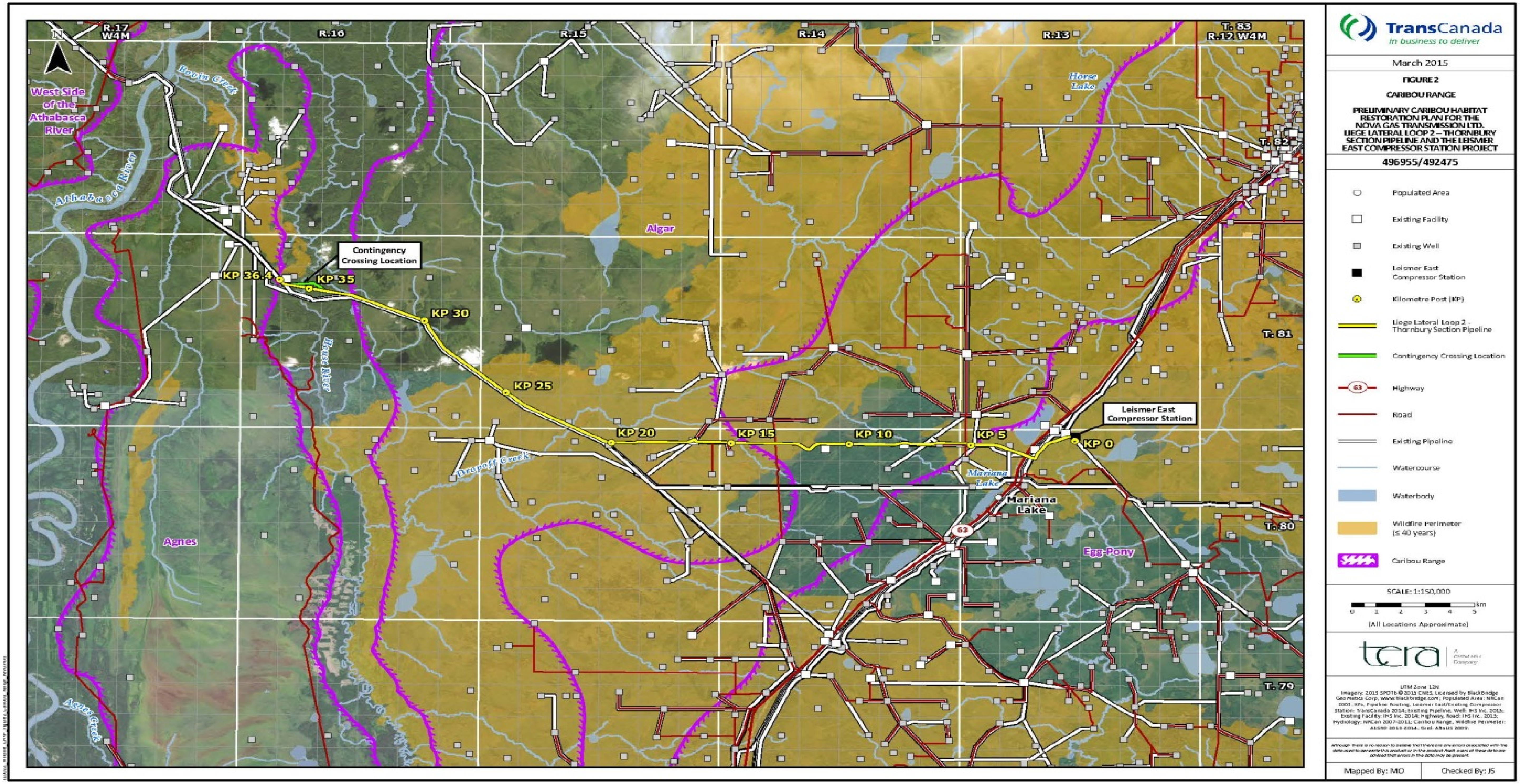


Figure 5-1: Caribou Range

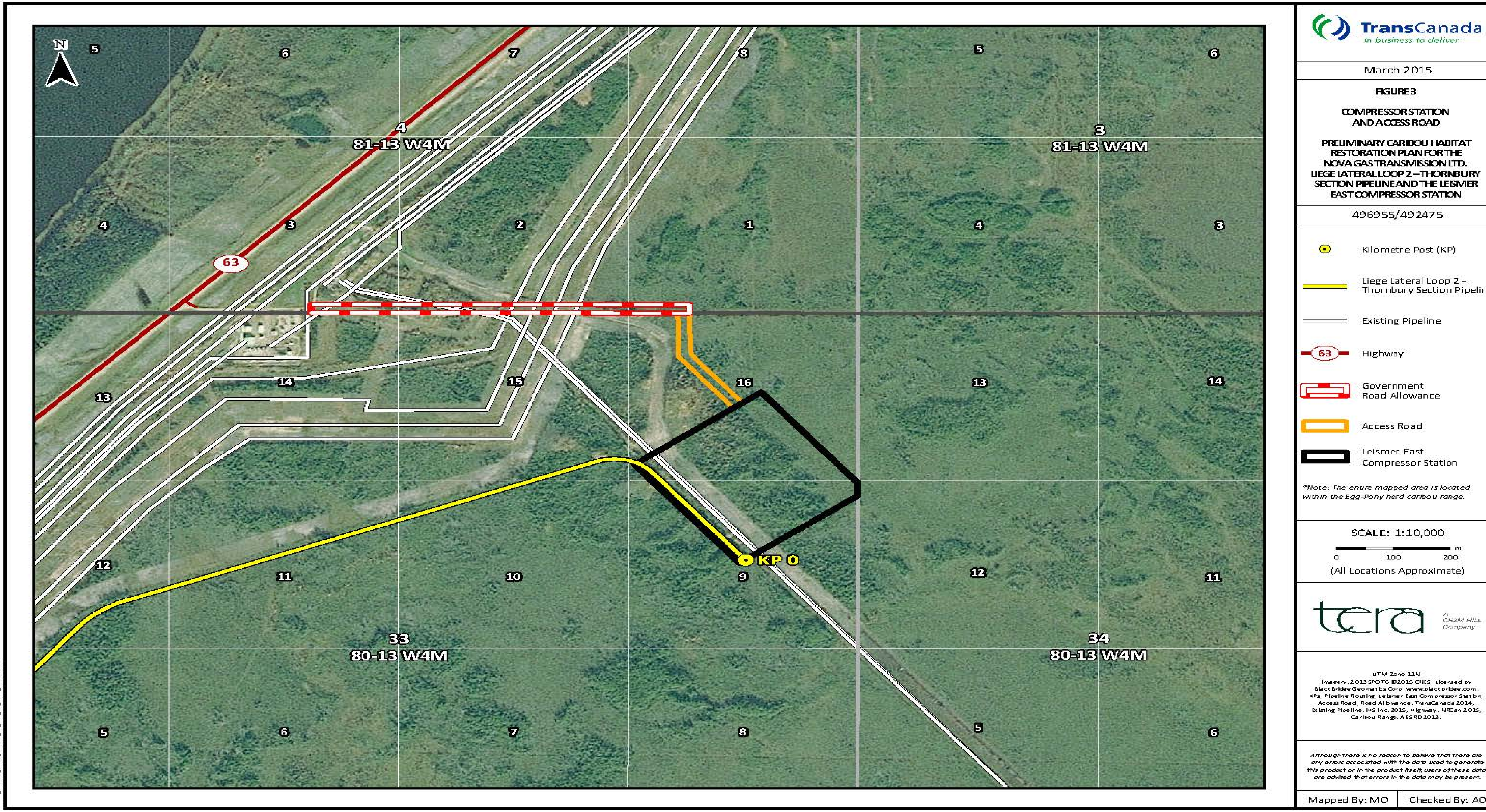


Figure 5-2: Compressor Station and Access Road

The spatial residual effect will be quantified using a method consistent with *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* (Environment Canada 2011, 2012). The Recovery Strategy defines undisturbed caribou habitat in the Environmental Site Assessment Repository (ESAR) caribou range as habitat that has not burned in the last 40 years and is not in or within 500 m of anthropogenic disturbance. Although the Project footprint is in an area that has been burned by forest fires within the last 40 years, NGTL will still consider this non-permanent disturbance in its quantification of spatial residual effect.

Restoration of the impacted ESAR caribou habitat through implementation of the CHRP measures will not completely eliminate adverse Project effects on caribou habitat. During operations, NGTL will periodically manage vegetation within 5 to 10 m of the centreline of the operational pipeline, in accordance with TransCanada operational procedures for integrity monitoring under Canadian Standards Association (CSA) Z662-15 (CSA 2015).

This area will be allowed to regenerate naturally, but will be periodically mowed or mulched. This theoretical access area will not achieve the quantifiable targets for the CHRP and is quantified as a residual direct disturbance of caribou habitat.

After application of the CHRP measures outlined in this document, the final disturbance footprint will be determined. Direct and indirect Project disturbance on caribou habitat will be quantified and presented in the Final CHRP, as outlined in Table 5-2.

Table 5-2: Quantification of Direct and Indirect Project Disturbance of Caribou Habitat

	Area (ha)			
	Direct Project Disturbance	**Restored Project Footprint**	**Residual Direct Project Disturbance**	**Incremental Indirect Disturbance**
Length of Pipeline Segment	TBD	TBD	TBD	TBD

The proportion of total area for each mitigation measure in each habitat type will be used to estimate the remaining Project effect using the following equation:

Calculation 5-1:

$$Remaining\ Project\ Effect\ (ha) = Inherent\ Project\ Effect\ (ha) \times \{1 - (Measure\ Effectiveness\ \times Delay\ Penalty)\}$$

To calculate the final offset requirement for the Project, the first step involves calculating the remaining project effect after CHRP measures are applied to the Project footprint. The restored Project footprint will be categorized as either new alignment or parallel alignment. New alignment is assumed to have full effect on caribou use of this part of the range , whereas segments parallel to adjacent disturbances have less effect on range caribou use (this will be further outlined in the OMP).

The second step (inherent project effect) involves categorizing the portion of total area for new alignment and parallel alignment in their respective habitat classes to apply the appropriate delay factors (i.e., time lags) associated with each mitigation measure.

The third step categorizes the proportion of total area for each mitigation measure in each habitat type.

The remaining project effect calculation will be used to populate Table 5-2 in the Final CHRP.

For previous NGTL projects that impacted caribou habitat, NGTL allowed intermittent alternating plantings of woody vegetation over the pipeline centreline. For the Project, trees will be planted across the centreline where open areas are left at alternating sides of the ROW. This will allow for a meandering access line over the centreline, and will in time, establish line-of-sight breaks (i.e., vegetation screens). Using this alternating planting method the quantifiable targets for habitat restoration (revegetation) are expected to be achievable in the long term.

The entire width of the Project planted footprint will not be considered restored in the short term. In the short term, there will be a spatial residual effect on the area of operational access. In the long term, the area of operational access is not expected to be a spatial residual effect where the ROW segment is planted with trees. The spatial residual effect is expected to be effectively addressed once the habitat regenerates in the long term.

Some restoration measures are designed to be effective immediately or in the short term. For example, retention of vegetated visual screens, mounding and tree felling (particularly if in conjunction with mounding) are expected to reduce Project residual effects on caribou habitat immediately.

The lag time required to achieve habitat value equivalent to pre-construction conditions is important and will be considered in the quantification of residual effects in the Final CHRP. Residual effects presented in the Final CHRP will consider spatial residual effect; lag time and the uncertainty associated with offsets (see Calculation 5-1). Over the long term, the vegetation community composition and structure is expected to mature to a seral stage that will provide functional caribou habitat and restore pre-disturbance predator–prey dynamics.

NGTL will develop an OMP to address Project residual effects on critical caribou habitat, in accordance with Condition 7. The Preliminary OMP will be filed with the NEB at least 90 days before requesting leave to open the Project. The Preliminary

OMP will further detail the method used to quantify the offsets. The Project OMP will use a method of offset quantification that aligns with NGTL's previous OMPs for projects constructed in boreal woodland caribou range. Residual effects will also be presented in the Final CHRP and will consider lag time and factor in uncertainty associated with offsets.

The residual effects to be quantified in the Final CHRP using the method described above will be modified in the calculation of residual effects in the OMP to factor in:

- uncertainty associated with effectiveness of the CHRP measures
- context of the footprint related to existing disturbance (e.g., contiguous or non-contiguous)
- time lag or duration of residual effects

5.3 HABITAT RESTORATION

The decision framework (see Section 3) and regulatory guidelines summarized in Section 8 provide the basis for the Preliminary CHRP and will further guide the Final CHRP. The decision framework provides direction on restoration factors such as variability in natural site characteristics, planting prescriptions, target vegetation, soil and site stability, and access management. This in-turn informs the quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects and the extent to which goals and objectives have been met.

For a suite of caribou habitat restoration measures, see Table 5-3. After applying the decision framework, suitable restoration measures will be selected. Several methods described in the literature review and included in Table 5-3 are considered not suitable given the limitations to implementation or effectiveness. These measures could be reconsidered, if additional information becomes available to support their use.

For photos of potential restoration measures, including site conditions showing constraints and opportunities, see Appendix A.

Site-specific caribou habitat restoration measures implemented for the Project will be described in the Final CHRP, which will include maps or Environmental Alignment Sheets showing the locations of selected sites.

For an illustrative table showing site-specific restoration methods and location details that may be included in the Final CHRP, see Appendix B. The Final CHRP table will also include the rationale for restoration measure selection, additional site-specific details to inform implementation and implementation status. Accomplishments and lessons learned from implementing and monitoring NGTL's other caribou habitat restoration initiatives will be included in the Final CHRP, and will inform the rationale for selection of restoration methods and locations. The Final CHRP will also include specification drawings of the restoration measures, in accordance with Condition 6b(iii).

Table 5-3: Habitat Restoration Measures

Restoration Measure	Objectives	Rationale	Comments
Berms	Access control Reduce line-of-sight	Berms can be constructed of coarse woody debris and timbers, or a combination of coarse woody debris and earth. Supported berms are constructed using timber cleared from the ROW. To effectively block line-of-sight, berms should be constructed to an approximate minimum height of 1.5-2 m. Promote rapid shrub/tree regeneration at ends of berms (e.g., shrub staking/transplants, seedling planting) to increase effectiveness as access control. Earth berms were 76% effective at excluding vehicles over 50 inch in width and 22% effective at excluding all vehicles including off-road vehicles (Esri User Conference 1996). Berms create a barrier that can be effective immediately following implementation. Coarse woody debris/timber berms are dependent on approval from provincial authorities to retain coarse woody debris on-site, as well as sufficient space to store the material during construction. Woody debris berms may present an increased fire hazard, depending on composition and location. NGTL has found on its existing ROWs where this measure was used, that woody debris berms deteriorate relatively quickly after installation (within several years), particularly if berms are moved to allow access to the ROW. Availability of source material is usually not sufficient for earth berm construction in areas where minimum disturbance construction techniques are employed. Importing material is not preferred given the risk of introducing invasive plants. Earth berms should not be located in peatlands due to potential for settling and alteration of surface hydrology.	Limitations of this measure reduce its value. Woody material available for inclusion in berms is often limited, so can make this option less useful. Woody debris berms might be used as CHRP measures if sufficient wood exists at the Project site. Earth berms will not be considered a viable option for the Project as NGTL has found that there is generally insufficient source material to create earth berms.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Bioengineering – shrub staking/planting or tree seedling planting	Habitat Restoration Access control Reduce line-of-sight	Bioengineering in combination with stabilization measures (e.g., soil wraps) might be suitable at watercourses crossed with an open cut method. It is the use of existing live vegetation to stabilize and revegetate a site (e.g., transplants; installing cuttings) and is a technique often used on slopes or riparian banks (Polster 2002). Species and planting densities used for bioengineering are site dependent (Golder 2012a). Vegetation used is typically collected either from the disturbance site (i.e., before or during clearing), or from the adjacent area, in the form of cuttings (Golder 2012a). Vegetation may be planted during the growing season or during winter. Willows and poplar can be used as cuttings. Both species are fast growing, which establishes line-of-sight breaks quickly and works well for riparian restoration (Golder 2012a). Nursery-grown shrub seedlings may be planted where staking is not practical due to lack of available material, limitations associated with collecting material off-site, or where a restoration prescription calls for shrub planting of species that do not readily regenerate through cuttings/staking (e.g., alder). Alder has low browse value for ungulates such as moose and deer. Compacted sites that are difficult to treat using mechanical site preparation methods can benefit from inter-planting alder with conifers. When alder is interspersed with conifer plantings, line-of-sight and human access on linear features can be reduced relatively quickly (compared to conifers alone). The nitrogen-fixing characteristics of alder can provide soil enhancement (Sanborn et al. 2001; Sweeney 2005), potentially promoting improved conifer growth over the long-term (Courtin and Brown 2001; Simard and Heineman 1996). The fast growth of alder can reduce growth rates of conifer plantings due to competition when alder densities are high (CRRP 2007b; Simard and Heineman 1996). Species are determined based on the adjacent forest stand and restoration objectives (e.g., low palatability for ungulates). Combined plantings of shrub and tree seedlings can be appropriate, depending on site conditions and anticipated natural revegetation of both species. Procurement of shrub seedlings (container or bare-root) can be challenging given limited seed availability. Planted shrubs can be slow to establish.	Shrub planting is a suitable CHRP measure for select site-specific locations if a need for combined conifer/shrub plantings is identified. Many shrub species can attract prey species such as moose and deer which can attract wolves thus its application will be limited as these species can have a negative effect on caribou (see Section 8).

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Conifer seedling planting	Habitat restoration Access control. Reduce line-of-sight	Species are determined based on the biophysical characteristics of the site, adjacent forest stand composition, and restoration objectives (e.g., low palatability for ungulates). Tree seedling planting is considered a long-term restoration treatment (effectiveness is expected to take longer than 10 years). Planting densities for reclamation of forested areas in Canada have been based on forestry standards, ranging from 1,500-2,500 stems/ha (MacDonald et al. 2012). The Government of Alberta (AESRD 2013b) *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* is unclear in its recommendations, stating that the expected planting density for sites planted with merchantable species is 2,000 stems/ha and vegetation assessments conducted at least two growing seasons after planting are expected to have a minimum stem density of 2,000 stems/ha. This allows for no seedling mortality. The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010) specify ranges of planting densities that vary by the site type and tree species planted. For example, to achieve medium to dense crown closure, the planting density of conifer (pine and white spruce) seedlings in dry, moist poor or moist rich site types is 1,400-2,000 stems/ha. In wet poor sites, the recommended planting density of black spruce is 1,400–2,800 stems/ha. The *Reforestation Standard of Alberta* (AESRD 2014b) is specific to reforesting cutblocks and defines successful regeneration as having 80% stocking of acceptable trees during establishment surveys conducted 4 to 8 years after harvest (i.e., 80% of sample plots have at least one live conifer tree 30 cm tall or taller, or one live deciduous tree that is at least 130 cm tall). This gives a minimum target stem density of approximately 800 stems/ha. Given the relatively harsh growing conditions inherent to boreal ecosystems, mortality of planted seedlings is anticipated to range from approximately 5% to 20% in most site types (Golder 2012a,b). A planting density of 2,000–2,500 stems/ha has been recommended for restoration of linear disturbances in boreal caribou ranges in northeastern BC (Golder 2015). A linear restoration matrix developed by AEP recommends a planting density of 1,200 stems/ha in boreal caribou range in Alberta (Vinge unpublished). Given the densities were developed for forestry practices and this project relates to linear ROWs, the monitoring program might show a reduced success rate and the survival target might need to be adjusted over time.	Conifer seedling planting is a suitable CHRP measure for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Conifer seedling planting (cont'd)	Habitat restoration Access control. Reduce line-of-sight (cont'd)	Based on the above information and also considering Alberta ecosystems, the following planting prescription has been formulated for this CHRP: • minimum live seedling density of 1,600-2,000 stems/ha on sites that are not mounded; • minimum live seedling density of 1,200-2,000 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites (dependent on mound density)	
Mounding	Restore vegetation (create microsites) Access control	For the purposes of enhancing microsites for planted seedlings, mounding is a well-researched and popular site-preparation technique in the silviculture industry. It is commonly used in wet, low-lying areas to create better-drained microsites to enhance seedling survival. Mounding treed wetlands (e.g., bogs, fens) can enhance a site to promote natural revegetation over time, as higher, drier spots are created that seed can eventually settle into and germinate (Golder 2012a; Macadam and Bedford 1998). Soil properties (e.g., substrate, drainage) affect the ability of mounds to retain their structure. Mounding has been used as an access control measure on old roads and seismic lines to discourage off-road vehicle activity. It can be effective immediately following implementation. For access control purposes, mounds should be created using an excavator to approximately 0.75 m deep, where site conditions allow (Golder 2012a). The excavated material is dumped right beside the hole (Macadam and Bedford 1998). Suggested densities of mounding for access control or microsite creation purposes vary from 1,200 to 2,000 mounds/ha (AENV 2010; Golder 2012a; Vinge unpublished). Implementation of this mound density may be suitable for restoring disturbances such as seismic lines where specialized equipment is used, and where frost is not driven into the soils to allow heavy equipment access. The mound density that can realistically be achieved on pipeline ROWs is lower since mounding is completed in conjunction with final cleanup. The limitations include scheduling mounding for restoration during final cleanup, which typically requires freezing-in of soils, availability of specialized equipment and minimum spatial separation of 5 m between mounds and the centreline of the operating pipeline. For previous NGTL caribou habitat restoration projects on pipeline ROWs, the achievable range in mound density was approximately 700-1,400 mounds/ha.	Mounding is a suitable CHRP measure that will be used in conjunction with conifer seedling planting for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Minimum disturbance construction	Habitat Restoration Reduce line-of-sight	Construction during winter conditions reduces the need for soil salvage and grading, and the width of grubbing is limited to the trench area where grading is required. Reduced disturbance to vegetation and root systems is achieved by cutting, mowing or walking down and mulching shrubs and small diameter trees at ground level. The intact root systems and seed bed with little soil disturbance facilitates rapid regeneration of vegetation. Use of snow padding or matting can limit the need for cutting or mowing shrubs and small trees, thereby speeding regeneration of native vegetation. The extent of minimum disturbance construction is limited by scheduling to avoid the restricted timing window for caribou (February 15 to July 15) and also by existing ground topography. Soil conditions limit the applicability of minimum disturbance construction methods. Construction in well to moderately drained sites during non-frozen conditions requires grubbing and grading to salvage surface soils so they can be stored separately from subsoils and replaced following construction. This prevents admixing and loss of the productive surface soils that facilitate regeneration of vegetation.	Minimum disturbance construction is a suitable CHRP measure for the Project, and will be implemented where scheduling, soil conditions (e.g., frozen), and topography allow.
Transplanting	Habitat Restoration Access control Reduce line-of-sight	Transplanting has the advantage of immediately establishing relatively large trees/shrubs (e.g., saplings). There are limitations to transplanting, including inconsistent availability of vegetation suitable for transplant, potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands, transplanting programs often result in the storage of plant materials under less-than-ideal conditions due to uncontrollable factors (i.e., weather) and other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison (Golder 2012a).	Transplanting of native vegetation is not a suitable CHRP measure for the Project as it has been shown to be a difficult technique to implement on a large scale, with marginal results and multiple limitations. This technique could prove more suitable for future projects if advances in the method improve survival success rates.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Tree felling or bending	Access control Habitat Restoration Reduce line-of-sight	Mechanically bending or felling live trees onto the linear disturbance has been tested as a measure to restore habitat and manage access on seismic lines in caribou range (COSIA 2012).Trees are typically bent or felled from both sides of the linear disturbance. Tree felling involves deliberately felling trees over the linear disturbance. It does not require specialized machinery andwill be considered where adjacent trees are tall enough. Tree bending requires specialized machinery to mechanically bend live stems over the linear disturbance. Mechanical tree bending can be expensive and time consuming. These measures are often used in conjunction with other restoration techniques such as mounding and conifer seedling planting. Tree felling/bending is only initially being evaluated and its utility remains unverified (Neufeld 2006). It is recommended that if tree felling is to be used as a line blocking measure, it should be investigated more thoroughly, and not solely be relied on as a mitigation tool (Neufeld 2006). Preferably, line-blocking with tree felling (or tree bending) should be used in combination with other management actions such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. Tree felling/bending can promote natural revegetation by increasing cone deposition onto the ROW, creating microsites through shading and dropped dead woody debris, and protecting planted seedlings from extreme weather, wildlife trampling and damage from access. Application in pipeline ROWs might be limited due to the width (i.e., much wider than typical seismic lines where tree bending/felling has previously been implemented). The narrowed permanent ROW does not include space for tree retention along edge of the ROW and requires trees to be felled from beyond the limits of a typical ROW as the edge of ROW is inherently variable due to spatial distribution of trees. Provided regulatory permitting (e.g., temporary field authorization to fell trees adjacent to the approved construction ROW) could be obtained, this measure could be a valid option for non-contiguous portions of the Project footprint.	Tree felling may be an option for the CHRP; however, due to the uncertainty of its effectiveness and limitations to application to pipeline ROWs, its application will be on a limited and/or trial basis for the Project. Another consideration for tree felling is the amount of available trees that can be used for the technique and that will be determined after final construction. Tree bending is not a suitable CHRP measure for the Project, given constraints associated with specialized machinery and time necessary to implement. As well, this technique is still being studied and as new research on the technique emerges, it could be considered for future projects.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Tree/shrub seeding	Habitat Restoration Access control Reduce line-of-sight	Species and application rates required are site dependent. Seeding is considered a long-term restoration treatment. Given the relatively narrow disturbance associated with linear developments such as pipeline ROWs in forested landscapes, native seed dispersal readily covers the disturbed area. Conifer cone crops can vary dramatically from year to year, and in some areas good cone crops are relatively predictable (given documented cycles and climatic conditions). Seeding could be a suitable measure if poor cone crops are expected for several years following reclamation, or if target species differs from the adjacent stand. Accessibility (i.e., distance to airport) can be a technical limitation if seeding is to be conducted aerially. Seed predation is also a limitation of applying tree seed.	Seeding is not a suitable CHRP measure, given logistical constraints (i.e., availability of native seed, accessibility of seeding equipment) and likelihood of native seed ingress from vegetation in the adjacent undisturbed areas.
Coarse woody debris	Access control Habitat restoration Reduce Line of Sight	Coarse woody debris rollback can be used for access control and to enhance restoration of natural habitat characteristics. Woody debris rollback can enhance revegetation as it can conserve soil moisture, moderate soil temperatures and provide nutrients as debris decomposes, prevent soil erosion, provide microsites for seed germination and protection for introduced tree seedlings (Pyper and Vinge 2012; Vinge and Pyper 2012). Fine woody debris (e.g., chipped or mulched debris) can be detrimental to soil thermal conditions, carbon:nitrogen (C:N) ratios and plant recruitment where the depth of debris is excessive (AENV 2010). Mulch depths less than 3 cm are preferred to avoid limiting natural ingress and vegetation growth (Pyper and Vinge 2012; Vinge and Pyper 2012). Coarse woody debris should be spread evenly across the entire width of the footprint at a coverage/density that will not restrict ability to plant seedlings or limit planted or natural seedling growth. Woody debris should be applied at a density/volume that does not exceed 400 tonnes/ha to discourage access along a ROW (Osko and Glasgow 2010). Where sufficient material is available, woody debris coverage can range from 60-100 m^3/ha on upland sites and 25-50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012). Where sufficient material is available, woody debris coverage of 150–250 m^3/ha along ROWs might be appropriate to manage access (Vinge and Pyper 2012). Coarse woody debris rollback blocks constructed at 500 m intervals can be used as reducing line of sight measures. To allow operational access, the blocks consist of three segments placed in a staggered pattern approximately 10 m apart.	Woody debris rollback is a suitable CHRP measure for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Woody debris (cont'd)	Access control Habitat restoration (cont')	Research presented at the North American Caribou Workshop (2014) suggested that application of high densities (200 m^3/ha) of salvage logs (i.e., rollback) at linear feature intersections reduces human use by 100%, wolf use by 90% and deer use by 50%. NGTL has found on previous caribou habitat restoration projects that coverage ranging from 200–300 m^3/ha can deter access while allowing sufficient spaces between the debris to allow seedling planting. Rollback can be effective immediately following implementation, provided adequate material is available and properly applied (Vinge and Pyper 2012). The implementation and length of a rollback segment is dependent on sufficient quantities of coarse woody debris during clearing of new disturbance and the trade-off between its use and the ability/space to store it during construction (CRRP 2007b). Long rollback segments are more effective at managing human access because ATV riders will be less inclined to try to ride through the debris or traverse around it in adjacent forest stands. Sections of rollback ≤ 100 m in length may not be effective at deterring motorized access (Vinge and Pyper 2012). An expert opinion survey cited 400 m long rollback segments as sufficient length (Golder 2007). Guidelines for application of rollback where materials are available recommend placement of rollback across the entire pipeline/easement width for a distance of at least 200 m from all points of intersection with wellsites, plant sites, roads and permanent watercourses (AER 2013). NGTL has found on previous caribou habitat restoration projects that material availability often limits the segment length that can be achieved to 50–100 m (75 m on average). Fire risk is a consideration when using or storing materials for rollback. Fire risk can be minimized through proper storage and placement of materials (Pyper and Vinge 2012). A 25 m rollback-free fuel break placed at 250 m intervals along rollback segments is is recommended by the *Integrated Standards and Guidelines for the Enhanced Approval Process* (AER 2013).	Woody debris rollback is a suitable CHRP measure for the Project.

5.3.1 Natural Regeneration

Minimum disturbance construction is a promising approach for promoting native vegetation re-establishment. Minimal disturbance procedures relate to the removal of vegetation, work area preparation and clean-up activities associated with construction of the Project. The objective of this construction technique is to minimize impacts on the soils and vegetation substructure, with the goal of allowing the Project footprint to re-vegetate to a similar pre-construction condition, subject to land-use guidelines specific to the disposition. NGTL will, therefore, implement minimal disturbance construction techniques to facilitate natural regeneration to restore habitat along the ROW. This construction technique is restricted to areas where grading is not required. Stripping and grading will be required in areas of significant cross-fall of the ROW (i.e., greater than 1.0 m), irregular ground profile along the pipeline, and at tie-in sites (road bores and pipeline crossings). Minimal disturbance installation is most suitable for straight pipe installation.

5.3.2 Tree Planting

Established reclamation and forestry reforestation practices will be applied to promote revegetation where natural regeneration might not achieve the quantifiable targets. Restoration measures that incorporate tree planting techniques, such as site preparation (e.g., mounding) and planting trees/shrubs, will be considered where site conditions allow (including construction methods and level of disturbance).

For a summary of habitat types that will be disturbed as a result of the Project footprint, see Table 5-4. For the planting prescription for each habitat type, see the performance measures identified in Table 4-1.

Table 5-4: Habitat Types in ESAR Caribou Range

Habitat Types	Ecosystem Description	Area (ha)	Percent of Total (%)
Treed Wetland	Wetland – Treed (81)	23.5	26.5
	Total	23.5	26.5
Shrubby/Herbaceous Wetland	Wetland – Shrub (82)	14.4	16.3
	Wetland – Herb (83)	17.2	19.4
	Total	31.6	35.7
Upland/Transitional Coniferous Forest	Coniferous Dense (211)	19.4	21.9
	Coniferous Open (212)	8.1	9.1
	Total	27.5	31.0
Upland/Transitional Deciduous and Mixedwood Forest	Broadleaf Dense (221)	5.1	5.8
	Mixedwood Dense (231)	0.6	0.7
	Total	5.7	6.5
Graminoid/Herbaceous	Herb (100)	0.1	0.1
	Total	0.1	0.1
Anthropogenic	Exposed Land (33)	0.2	0.2
	Total	0.2	0.2
All Habitat Types	**Total**	88.6	100

Implementation targets and specifications for habitat restoration (e.g., seedling planting densities, mounding densities) will be designed to meet the quantifiable targets for the CHRP. These will be informed by available guidelines and standards (see Section 8), NGTL's experience implementing caribou habitat restoration measures and complementary research.

For the planting prescription for each habitat type, see the quantifiable targets column in Table 4-1. The quantifiable targets and performance measures in Table 4-1 should be considered preliminary and subject to change. The restoration methods and targets will be affected by variables such as extent of grading, construction method and availability of shared workspace and access. The proposed habitat restoration quantifiable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends of conifer and deciduous trees within 15 years following completion of restoration. These targets are to be met over the portion of the Project footprint available for restoration (i.e., excluding overlap with third-party developments or operational access outside planted areas).

5.4 ACCESS CONTROL

The goals of access control for the Project in caribou habitat are to:

- manage access along the pipeline ROW in a manner that discourages all forms of access
- maintain accessibility necessary for safe pipeline operations compliant with applicable regulations and guidelines
- maintain existing access at identified locations (e.g., third-party industry access, traditional access identified by Aboriginal communities through engagement activities)

5.4.1 Baseline Data on Access Control

Geographic Information System (GIS) will be used to mark selected locations of monitoring plots in order to establish the baseline assessment for this Project. The locations will be chosen based on a review of the Project's construction alignment sheets and proposed access control treatment locations.

Based on early review of the Project's spatial configuration, 32 existing linear features (for example, seismic lines, utilities corridors or roads) have been identified that intersect with the Project ROW. NGTL will control access where the Project intersects active crossings, and will assess these areas as potential treated sites.

An assessment of these potential control sites will include the deployment of Reconyx remote cameras over a six week period. However, several of the sites cross wetlands with little or no trees and may not be good candidates for access control treatments. The Final CHRP will outline a detailed review of the baseline access study and further detail the final locations of the monitoring plots.

5.4.2 Access Control Measures

Access control measures are most effective when implemented on non-contiguous segments of the pipeline portion of the Project ROW, and at intersections of the pipeline portion of the Project's ROW with existing perpendicular linear features (e.g., roads, utility corridors, seismic lines). Quantifiable targets and criteria used to evaluate the effectiveness of access control measures will align with those in the CHROMMP.

Access control measures that will be considered for the Project, but not necessarily utilized, include:

- extended bored crossings
- vegetation screens
- rollback
- fencing and signs
- vegetation planting
- mounding
- installation of berms
- tree felling over the ROW

Rollback, mounding and planting vegetation will be the key access control measures implemented for the Project. Some of these measures might not be selected for final restoration because of site-specific conditions. For example, lack of materials necessary for the installation of berms could limit the applicability of berm installation for this Project.

Locations for access control measures on the pipeline ROW will focus on intersections with other linear features, such as roads, utility ROWs, seismic lines or watercourses and non-contiguous sections of the ROW. NGTL might install signs at select locations to discourage access.

5.5 LINE OF SIGHT BLOCKING

Line-of-sight blocks include planting vegetation (e.g., tree planting or willow staking), fabricated site screens and minimal disturbance construction to preserve vegetation. Line-of-sight blocks will be implemented in locations with sightlines >500 m, particularly where they intersect with existing road access. Trees will be planted in an alternating pattern across the pipeline centreline along portions of the ROW. Specifically, trees will be planted across the centreline with open vegetation left at alternating sides of the ROW along some sections. This alternating vegetation pattern will create a line-of-sight break. Details on exact configuration of seedling planting to achieve line-of-sight breaks depend on as-built location of the pipe centreline and adjacent linear disturbances.

Measures to reduce sightlines might discourage access and might also decrease predator efficiency. In nature, sightlines are often longer in more open habitats of lowland muskeg communities compared with upland forest communities. As a result, line-of-sight distances can vary, depending on the location and structure of the adjacent vegetation community. In forested areas of the Project footprint where sightlines are 500 m long or more, line-of-sight blocks will be established.

There are no provincial guidelines in Alberta for line-of-sight management for linear features. Reclamation programs for previous developments in Alberta have targeted maximum sightlines of 400 m (Golder 2007; DES 2004). Operating practices for energy development in sensitive caribou range in BC (BC Ministry of Environment 2011) suggest implementing line-of-sight management every 500 m on linear features that do not share a ROW boundary with a road (see Section 8). As science is still emerging in this area, the long term monitoring of this and other NGTL CHRP measures, will be modified based on monitoring results to determine the appropriate line of sight breaks.

NGTL has implemented 500 m line-of-sight breaks to be consistent across provincial boundaries regardless of the location of the pipeline segment and has incorporated this approach in other Project CHRPs. Previously, NGTL attempted to apply the line of sight and access control features on the landscape as suggested in the Alberta Energy Regulator (AER) Enhanced Approval Process (EAP); however, it has become apparent that over the course of implementing those features on other NGTL projects that impact caribou habitat (Leismer, NWML, Chinchaga) meeting the recommended intervals was not feasible. In particular, recent field experience on the Chinchaga Section provided several examples of why these features cannot be applied at EAP recommended intervals. For lessons learned on other NGTL projects about implementing line of sight blocking intervals see Section 6.3.

Topography, bends in the ROW, minimum disturbance construction to preserve vegetation and willow staking create immediate line-of-sight blocks (i.e., create visual barriers after restoration activities are implemented). Line-of-sight measures such as tree plantings will be implemented in areas where sightlines are not blocked by terrain or bends. Planting at staggered intervals across the pipeline centreline will establish these 500 m line-of-sight breaks in the long term.

The exact locations for implementing line-of-sight breaks will be determined after construction and presented in the Final CHRP.

5.6 MONITORING AND ADAPTIVE MANAGEMENT

NGTL will create a CHROMMP for the Project to monitor effectiveness of planned habitat restoration measures that will be fully described in the Final CHRP. Adaptive management, i.e., the systematic process of monitoring and assessing outcomes and modifying restoration measures if necessary, will be implemented by adjusting and/or supplementing restoration measures, where warranted, to achieve the objectives of the CHRP.

Given that science is still emerging on caribou habitat restoration methods and effectiveness, adaptive management principles will be an important means of addressing uncertainty.

Monitoring will be conducted for up to 15 years, starting one year after CHRP measures have been implemented. At each monitoring interval, performance measures will be evaluated and compared with quantifiable restoration targets. If measures indicate that restoration has achieved or is on a trajectory to achieving targets, no further restoration measures will be undertaken. If, however, at any point in the monitoring program evaluations indicate that targets are unlikely to be achieved after 15 years, restoration measures must be adjusted and additional monitoring (longer than15 years) added.

This could include implementation of existing restoration measures or new measures, discovered through research or industry practice, that are proving to be successful. For example, NGTL is engaged in linear feature restoration research with the Regional Industry Caribou Collaboration in northeastern Alberta and lessons learned from this research can be applied to the Project.

Monitoring results, as well as any necessary adaptive management actions, will be reported to the NEB, Environment Canada and AEP following the end following each monitoring interval.

Habitat restoration measures that require adaptive management at the conclusion of the 15-year monitoring program will require additional ground-based monitoring until they are successful. If adaptive management actions fail, a revised monitoring program and timeframe will be developed to address unsuccessful measures.

This Preliminary CHRP includes brief descriptions of the restoration targets and how they will be measured. The Final CHRP will detail the actual habitat restoration methods implemented and their locations in the Project footprint. The residual disturbance to critical caribou habitat resulting from the Project will be calculated and finalized in the OMP for the Project. Specific details on the quantitative framework of the monitoring program frequency, timing and locations will be included in the CHROMMP. The CHROMMP will describe a comprehensive monitoring program for Project CHRP measures and potential offset areas, as finalized in the OMP, to compensate for residual effects in caribou habitat.

5.7 QUANTITATIVE FRAMEWORK

NGTL will implement a monitoring program to verify the effectiveness of CHRP and OMP measures and plans to integrate monitoring outcomes into future decision-making as part of a continual improvement process. The monitoring program will employ a quantitative framework using both aerial and ground-based sampling protocols to assess the effectiveness of habitat restoration, access control and line of sight blocking measures. As discussed above, specific details concerning the monitoring program methods will be discussed in the CHROMMP. The following provides a brief example of the quantitative framework used to assess habitat restoration effectiveness (i.e., revegetation) in upland/transitional coniferous forest as a preliminary guide.

5.7.1 Experimental Design

A one-way repeated measures experimental design will be used to evaluate restoration effectiveness for each individual habitat type separately due to the inherent differences associated with their biophysical characteristics. Repeated measure designs are generally preferred over other factorial designs as they improve the precision of estimates derived on the response variable (Montgomery 2001; Kuehl 2000). Quantifiable targets associated with each restoration measure collected during the monitoring program will be repeated at each monitoring plot location for each monitoring year. The experimental design is represented by the following model:

$$y_{ik} = \mu + \alpha_i + \tau_j + \varepsilon_{ij}$$

where y_{ik} is the estimated response of the quantifiable target, μ is the overall mean, α_i is the effect of each monitoring year, τ_j is the effect of each monitoring plot and ε_{ij} is the natural variability (i.e., error) (Montgomery 2001). The model term τ_j denotes the repeated measure effect associated with each monitoring plot, each monitoring year. The degree to which restoration measures achieve their respective targets will be determined by a positive difference of the mean for each quantifiable target between each monitoring year, where the first monitoring year will act as a baseline.

5.7.2 Results

Table 5-5 provides an example subset of data for upland/transitional coniferous forest with vegetation height (m) as the quantifiable target. To illustrate the proposed repeated measure design, statistical analysis and results, the following example is demonstrated for five sample plots across five monitoring years.

Table 5-5: Example Data Subset for Upland/Transitional Coniferous Forest (Vegetation Height)

Monitor Plot ID	Habitat Type	Description	Location (KP)	Monitoring Year	Vegetation Height (m)
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	1	0.19
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	1	0.13
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	1	0.15
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	1	0.19
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	1	0.16
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	2	0.22
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	2	0.16
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	2	0.22
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	2	0.26
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	2	0.27
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	3	0.41
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	3	0.48
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	3	0.49
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	3	0.40
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	3	0.40
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	4	1.20
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	4	1.12
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	4	1.32
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	4	1.41
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	4	1.36
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	5	2.10
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	5	2.23
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	5	2.56
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	5	2.80
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	5	2.65

Habitat restoration is achieved when a positive increase in mean vegetation height is observed between the first monitoring year (i.e., baseline) and each subsequent monitoring year. As such, the analysis focuses on the mean difference in vegetation height for the fixed effect monitoring year, with monitoring plots treated as random effects to control for natural variability associated with each monitoring plot.

Table 5-6 provides a summary of the model output and pairwise comparisons used to identify differences in mean vegetation height between the first monitoring year and each subsequent monitoring year. In the example, a significant difference is observed for the fixed effect monitoring year (p<0.001). Pairwise comparisons of mean vegetation height (m) between the first monitoring year and each subsequent year demonstrate a positive increase in mean vegetation height between each monitoring year, with the exception of the second monitoring year (p=0.940). Ongoing review and monitoring comparisons will be integral in determining if vegetation targets can be met and then can be used in effectiveness determination.

Table 5-6: Example Results for Upland/Transitional Coniferous Forest (Vegetation Height)

Model Output

Factor	Type	Levels Values
Monitoring Year	Fixed	1, 2, 3, 4, 5
Monitor Plot ID	Random	Liege U 1, Liege U 2, Liege U 3, Liege U 4, Liege U 5

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Monitoring Year	4	19.073	4.7683	282.80	**<0.001**
Sample Plot ID	4	0.1493	0.0373	2.21	0.113
Error	16	0.2698	0.0168		
Total	24	19.492			

Pairwise Comparisons of Mean Vegetation Height (m)

Monitoring Year	N	Mean Vegetation Height	Grouping
5	5	2.468	A
4	5	1.282	B
3	5	0.436	C
2	5	0.226	CD
1	5	0.164	D

Means that do not share a letter are significantly different.

Monitoring Year Comparison	SE of of Means	Simultaneous Difference	Adjusted 95% CI	T-Value	P-Value
2 – 1	0.062	0.0821	(-0.1894, 0.3134)	0.75	0.940
3 – 1	0.272	0.0821	(0.0206, 0.5234)	3.31	**0.031**
4 – 1	1.118	0.0821	(0.8666, 1.3694)	13.61	**<0.001**
5 – 1	2.304	0.0821	(2.0526, 2.5554)	28.06	**<0.001**

5.8 SCHEDULE

Scheduling and logistical coordination before restoration implementation will consider seasonal access constraints, critical timing periods for caribou and other valued components, production of nursery seedlings and appropriate timing for restoration efforts (e.g., season of planting).

Final cleanup activities will be completed following construction and within one year following the start of operations. As-built construction information will be compiled following construction and used to determine appropriate site-specific restoration measures and access control locations. Final site selection for caribou habitat restoration treatments will be completed during the first growing season following construction.

For the current proposed schedule for construction and habitat restoration activities, see Table 5-5.

5.8.1 Caribou Timing Windows

NGTL is employing an early in/early out strategy to reduce disturbance of caribou by initiating activities as early as possible in the winter and working expeditiously to limit late winter activities.

Clearing activities at the compressor station will be complete and the site will be fenced prior to February 15, 2016, after which work will generally occur within buildings. Pipeline access preparation and clearing will commence in mid-September 2015 as conditions allow, and will be completed prior to February 15, 2016. NGTL is committed to reporting construction progress to the regulators on a bi-weekly basis so they are informed of any circumstances that may lead to delays with the construction schedule.

Final clean-up and reclamation is scheduled to occur in early winter 2017 during frozen conditions and in the late summer, outside the February 15 to July 15 timing restriction.

Table 5-7: Liege Lateral Loop 2 Construction and Habitat Restoration Schedule

	2015												2016												2017											
	Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Caribou Timing Window																																				
February 15 to July 15																																				
Clearing, Construction and Clean-up																																				
Clearing and construction of the compressor station site and access road																																				
Pipeline access preparation, right-of-way and temporary work space clearing in the Egg-Pony and Algar Caribou Ranges																																				
Pipeline construction in the Egg-Pony and Algar Caribou Ranges																																				
Final clean-up																																				
Caribou Habitat Restoration																																				
Planning Prelim. CHRP and access management																																				
Camera deployment for baseline access control data collection																																				
Field assessments and planning Final CHRP																																				
Seedling procurement																																				
Nursery seedlings grown																																				
Site preparation and access management implementation																																				
Shrub staking, bio engineering (riparian areas) and seedling planting																																				

6.0 CONTINUOUS IMPROVEMENT

This Preliminary CHRP has incorporated updated results from ongoing literature assessment, research completed by industry associations, lessons learned from previous NGTL projects, consultation with applicable regulators and resource managers, and adaptive management practices in the field.

This section describes caribou habitat restoration initiatives, industry collaboration and lessons learned by NGTL on other projects with caribou habitat. Continuous improvement comes from NGTL's analysis of the monitoring program (short term), applied practice (near term) and pure research (long term).

6.1 CARIBOU HABITAT INITIATIVES

Although restoration ecology specific to caribou habitat is a relatively new science, some key initiatives have identified important lessons learned related to oil and gas development in caribou range. Common among many of these initiatives are lessons learned on which plant species to use, when and where to replant, development of effective techniques to promote natural revegetation and a better understanding of methods to manage access. Lessons learned from these initiatives were incorporated in large-scale habitat restoration projects near Grande Prairie, Cold Lake and Fort McMurray, Alberta, as well as NGTL's projects in caribou habitat.

These initiatives focused on revegetation and access management, as well as limiting growth and establishment of plant species favourable to primary prey (e.g., Caribou Range Restoration Project [CRRP] 2007a,b; Golder Associates Ltd. [Golder] 2010; Osko and Glasgow 2010). Projects also included tree planting initiatives, coarse woody debris management best practices, habitat enhancement programs and habitat restoration trials in caribou range (CRRP 2007a,b; Enbridge Pipelines [Athabasca] Inc. [Enbridge] 2010; Golder 2010, 2011; COSIA 2012).

Blocking line-of-sight is a tool implemented through land use guidelines to mitigate increased risk of predation in the short term, while longer-term goals of revegetation of sightlines are achieved.

6.2 INDUSTRY COLLABORATION

Canada's Oil Sands Innovation Alliance (COSIA) was launched in 2012 to enable responsible and sustainable growth of Canada's oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation (COSIA 2012).

The organization's four key focus areas are tailings, water, land and greenhouse gases. Part of the land focus area is a caribou habitat restoration initiative with the goal of improving woodland caribou habitat quality and herd survival through restoration of historic linear disturbances.

COSIA has developed the following habitat restoration initiatives:

- Determining effectiveness of different restoration techniques such as winter tree planting, mounding, seeding and placement of coarse woody debris. The winter tree planting trial was set up to determine the effectiveness of planting black spruce seedlings in wetland areas during winter. Results of the tree planting trial indicated 90% survival of the 900 seedlings planted.
- Development of the Landscape Ecological Assessment Planning (LEAP) tool to provide baseline levels of varying land use. LEAP can be used to determine the long-term effects of restoration in a given area, which can help guide planting initiatives.
- The Algar Historic Restoration Project takes an integrated regional approach, with six companies working together to repair fragmented habitat across an area of land outside their actual licence areas. This is a five-year program to replant trees and shrubs along the linear footprint in the Algar Region, covering an area approximately 570 km^2.
- The LiDea Project aims to restore linear disturbances using mounding and tree felling. Rigorous monitoring and measurement programs have been designed for the life of the project, and currently include 37,000 ha of active treatment area. During spring and summer, conifer seedlings are planted along older, mounded seismic lines. LiDea is also experimenting with forest stand modification, which involves bending tree stems from the adjacent forest across the seismic line to create physical barriers and reduce sightlines along the linear corridor.

The Regional Industry Caribou Collaboration (RICC) is part of COSIA, and is a multi-industry partnership focused on restoring caribou habitat through regional, collaborative, range-based efforts. The objectives of RICC are to coordinate habitat restoration in the short term and long term, coordinate future activity, support and lead scientific research, conduct applied trials and align caribou habitat restoration programs with provincially led Range Plans and Action Plans.

NGTL has recently joined RICC. A major RICC research effort is to verify the effectiveness of restoration measures using a multi-scale predator/prey collaring program to address current knowledge gaps in habitat use and function. As new information on habitat restoration becomes available, NGTL will incorporate it in the planning and implementation process for its projects in caribou habitat.

6.3 LESSONS FROM NGTL HABITAT RESTORATION

Preliminary and Final CHRPs were completed for NGTL's Northwest Mainline Expansion Project, Leismer to Kettle River Crossover Project and Chinchaga Lateral Loop No. 3 Project (Chinchaga Section). Based on NGTL's experience with these three projects, the following lessons learned were incorporated in this Preliminary CHRP:

- Rollback was used as firewood by land users when stacked as ladders. A more random arrangement of wood piles to discourage wood removal might be used in the future.
- Line-of-sight breaks on co-located ROWs are not effective because of unrestricted access on parallel ROWs. NGTL has learned that such methods are better used in non-contiguous ROWs and that such line-of-sight breaks are redundant on contiguous ROWs. There have been structural stability issues with constructed line-of-sight blocks (versus vegetation screens). NGTL has, therefore, been experimenting with constructing alternative line-of-sight structures (e.g., snow fencing constructed with 2x4s was tested during winter 2014/15).
- Tree planting on a linear corridor appears to not be as effective as on cutblocks (typical silvicultural practices) because of shading. This could result in changes to the planting densities and configurations as the monitoring program progresses.
- Access control cannot be absolute because of safety, operating and maintenance activities that must occur. On previous NGTL projects, lack of access resulted in CHRP measures being destroyed or removed by TransCanada staff to access the ROW. In the future, access-control locations will be strategically placed to allow for maintenance and traditional use access.
- Where CHRP measures have failed or been removed, they have been replaced as part of adaptive management.
- As NGTL has attempted to apply the line of sight/access control features on the landscape as suggested in the EAP; however, it has become apparent that over the course of implementing those features on other NGTL projects that impact caribou habitat (Leismer, NWML, Chinchaga) meeting the recommended intervals was not feasible. For further details about why NGTL has not adopted the EAP suggested intervals, see Section 5.5.
- Based on recent field experience on the Chinchaga Section with implementing access control and line of sight blocks, NGTL determined that there are several reasons why these features cannot be applied at EAP recommended intervals and the intervals that were identified within the decision framework from the Chinchaga Final CHRP:
    - Materials to construct line of sight blocks are not often available and limit the capacity to implement at the EAP recommended intervals (for example, 200m and 400m):

    - There would be insufficient woody material to implement line of sight blocks, even using merchantable timber, to construct these features every 200m to 400m.
    - There is often not enough suitable material to implement rollback at the EAP recommended intervals.
    - Limited opportunities to implement mounding due to the unsuitability of soil types and ecosite type.
  - Conflicting interests for timber and woody materials:
    - Timber salvage waivers must be approved prior to construction and acceptable to the Forest Management Agreement (FMA) holder
    - In regards to woody materials, merchantable timber is prioritized first and used for access control then the remaining materials go to FMA.
    - Any woody materials remaining must be distributed efficiently among the locations where CHRP measures are required (line of sight blocks, mounding).
    - Often NGTL has experienced a lack of available material to implement CHRP measure at 500m intervals.
  - Operational concerns:
    - From a safety and maintenance perspective, implementing CHRP measures at 200m and/or 400m makes operational access difficult and potentially unsafe in case of an emergency situation precious time would be lost removing the access control and line of sight measures.
    - For Leismer in particular, NGTL personnel had issues gaining access to the ROW as a result of access control measures. These measures were then removed to gain access. However, the integrity of the wood feature had degraded so replacement of the feature was not possible. There were no additional replacement materials available to reconstruct the feature.

7.0 CONSULTATION

This section summarizes NGTL's caribou-related consultation with EC and AEP for the Project (see Table 7-1).

NGTL began consultation and working collaboratively with provincial regulators, Aboriginal communities, stakeholders and industry partners several years ago at the outset of the Project and will continue to work with provincial and federal regulators to align the CHRP measures with provincial and federal policies.

This Preliminary CHRP was developed based on ongoing consultation with EC and AEP. NGTL will continue to work with AEP to identify and address caribou-related concerns before construction, and will continue to facilitate open communication throughout Project execution.

A draft Preliminary Caribou Management Plan (CMP) was provided to federal and provincial regulators for review. The CMP was replaced by this Preliminary CHRP following receipt of draft Conditions from the NEB. The key recommendations from EC were to reduce the Project footprint by paralleling existing linear features and avoid sensitive periods for caribou. In June 2015, NGTL received extensive feedback from AEP on the Preliminary CHRP, which has been incorporated in this document. General concerns included:

- use of ambiguous language
- lack of clear definition of quantifiable targets and performance measures
- adherence to restricted activity periods (RAP)
- implementation of a caribou monitoring plan

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Environment Canada				
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	June 18, 2014 June 27, 2014 July 18, 2014 Email	June 18, 2014: NGTL provided project description and proposed schedule to EC and inquired about starting work at the compressor station during the caribou timing restriction. June 27, 2014: EC stated that mitigation principles should be in accordance with the following hierarchical sequence: avoidance, mitigation and compensation/offset for any residual environmental effects that cannot be avoided or sufficiently minimized. July 18, 2014: NGTL stated that NGTL is awaiting provincial guidance on whether clearing at the compressor station can occur within the caribou timing restriction.	5.6 4,5,6,7 5.1	The schedule is provided in Section 5.6. The mitigation hierarchy is applied to the CHRP, and is reflected in the measures described in Section 4 to Section 7, which span pre-construction (planning), construction, post-construction (restoration) and operations phases. Offsets will be addressed in the OMP and CHROMMP as per Conditions 7 and 8. Timing windows are discussed in Section 5.1.
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	February 3, 2015 Email	NGTL stated that an NEB approval has been received (Order XG-N081-003-201). NGTL stated that they are committed to completing a CHRP, an OMP and a CHROMMP for the Project. NGTL asked how EC would like to be consulted with respect to these plans. EC would like to review all caribou management plans.	1.2	The Preliminary and Final CHRP will be provided for EC review. NGTL plans to also provide EC the OMP and CHROMMP for review.
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	March 30, 2015 Email	Draft Preliminary CHRP sent to EC for review and comment.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Environment Canada (cont'd)				
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	April 17, 2015 Email	EC reviewed the Preliminary CHRP and had few concerns overall. EC identified concern regarding the method used to quantify residual effects in burned areas, and the implications for quantifying offsets. EC advises that some burned areas might be only 10 years from providing good habitat and the Project could set this area back another 30 years. Therefore, burned areas should not be excluded entirely from the quantification of residual effects and offsets. Additionally, EC advised that there will be a considerable time lag before the plantings in restored areas are effective, and this should be considered in the determination of residual effects and offsets.	6.2	NGTL will quantify direct and indirect spatial residual effects in the Final CHRP. The method to quantify residual effects has been clarified in Section 6.2 since the draft version of the Preliminary CHRP reviewed by EC. The temporal aspect of the residual effects will be discussed in the Final CHRP, and will be incorporated in the method used to determine offsets (e.g., offset ratios reflect time lag considerations).
Alberta Environment and Parks				
Steven Stryde Forest Officer Ed Barnett Forest Officer Wandering River, AB David Lind Land Management Planner Lac La Biche, AB	April 9 and 15, 2013 April 24 and 25, 2013 Email Telephone	NGTL provided factsheet and overview of Project. NGTL requested a time to meet and discuss Project details.	–	N/A
David Lind Land Management Planner Lac La Biche, AB	May 1 and 2, 2013 Email	NGTL followed up with meeting request.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks (cont'd)				
Ed Barnett Forest Officer Wandering River, AB David Lind Land Management Planner Lac La Biche, AB	May 16, 2013 Meeting	NGTL provided a Project overview. There is currently no AESRD contact for receipt of the CMP. May 17, 2013: NGTL provided AESRD with the meeting minutes.	–	N/A
Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	July 16, 2013 Telephone, Email	NGTL provided a Project overview and requested a discussion about the Project CMP. AESRD requested that information also be provided to Joann Skilnick.	–	N/A
Grant Chapman Senior Wildlife Biologist Lac La Biche, AB Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	September 25, 2013 Email	NGTL provided AESRD a Project overview and update.	–	N/A
Ed Barnett Forest Officer Wandering River, AB Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	January 31, 2014 Email March 11, 2014 Meeting	January 31, 2014: NGTL invited Ed Barnett, Joann Skilnick and Grant Chapman to attend a meeting in Wandering River March 11, 2014 to discuss Project construction in caribou range. March 11, 2014: Meeting with Ed Barnett. NGTL stated that a discussion with AESRD Fish and Wildlife is necessary to discuss construction constraints and the possibility of constructing the compressor station during the caribou timing restriction.	5.1 5.6	Section 5.1 discusses the caribou timing window and NGTL's approach to "early in/early out" scheduling and additional mitigation to reduce the duration of activities that might extend past February 15. Section 5.6 provides the proposed construction and restoration schedule.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks (cont'd)				
Bill Black Acting Approvals Manager Athabasca, AB Ed Barnett Forest Officer Wandering River, AB	April 22, 2014 Email	NGTL experienced difficulties reaching the AESRD Wildlife Biologist in Fort McMurray, and requested AESRD's direction regarding project constraints (i.e., scheduling) with respect to constructing in the caribou range.	5.1 5.6	Section 5.1 discusses the caribou timing window and NGTL's approach to "early in/early out" scheduling and additional mitigation to reduce the duration of activities that might extend past February 15. Section 5.6 provides the proposed construction and restoration schedule.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB Ed Barnett Forest Officer Wandering River, AB Bill Black Acting Approvals Manager Athabasca, AB	May 4, 2014 June 19, 2014 July 16, 2014 Emails	May 4, 2014: AESRD (Joann Skilnick) recommended that the company develop a caribou habitat restoration plan, and encouraged coordination with restoration activities occurring on adjacent pipeline ROWs. June 19, 2014: NGTL requested whether construction of the compressor station can occur within the caribou timing window given that it is considered a permanent installation. July 16, 2014: NGTL inquired whether AESRD had had a chance to consider the information request from June 19, 2014.	1.2 5.1 5.6	NGTL will prepare Preliminary and Final CHRP in accordance with NEB Order. Construction and commissioning of the compressor station is planned to start outside the timing window for caribou (i.e., after July 15, 2015) but activities will extend to April 2016, which overlaps the timing window for caribou. Section 5.1 provides NGTL's approach to scheduling, and Section 5.6 provides the construction schedule.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	November 11 and 13, 2014 Email, Telephone	November 11, 2014: NGTL provided an update on the CMP schedule and requested a meeting to discuss. November 13, 2014: NGTL provided shapefiles and project fact sheet to Joann Skilnick and requested confirmation of meeting on November 28, 2014.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks (cont'd)				
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	November 28, 2014 Meeting	NGTL provided an update of Project route, location and schedule. NGTL introduced the draft CMP to AESRD and discussed the differences between a CMP and a CHRP. AESRD recommended: • specifically linking mitigation to the desired outcomes listed in the EAP guidelines • demonstrating clearly how they link back, as opposed to the current EPP format used • including monitoring plans, monitoring to be effective – monitoring wolf densities or have wildlife cameras • avoiding use of following terms – "if practical," "if feasible" or "if possible" – identify when it will or won't be specifically • include information on helicopter protocols • include restoration AESRD requested in the CHRP that NGTL address access management plan. AESRD also advised that all areas have "facilitated" restoration unless evidence of where natural recovery is appropriate. Lastly for restoration, AESRD recommended that NGTL follow CEMA Restoration Guidelines (Stony Mountain Linear Restoration Project).	4 to 6	The CHRP incorporates the mitigation hierarchy (i.e., avoid, minimize, restore) to achieve CHRP goals and objectives (Section 2). Measures described in Section 4 to Section 6 reflect the mitigation hierarchy and are designed to achieve CHRP goals and objectives. EAP guidelines were considered in development of CHRP measures. Factors that constrain implementation are listed, where mitigation or restoration commitments include qualifiers such as "where site conditions allow." The CEMA Stony Mountain linear footprint and access management multi-stakeholder planning pilot project (Ohlson 2014) was reviewed during evelopment of the Preliminary CHRP. Intent of the project was to provide regional-scale recommendations amenable to a broad range of stakeholders, and inform design and implementation of future multi-stakeholder subregional planning processes undertaken as part of implementing the Lower Athabasca Regional Plan. The report provided high-level considerations and recommendations for planning multi-stakeholder restoration projects and managing linear features and access at the regional scale. The CHRP aligns with the applicable linear footprint and access management actions listed. The habitat and site-condition approach to selecting restoration methods and locations for the CHRP align with CEMA's suggested ecosystem-based revegetation matrix that was developed to support prioritization of linear features for treatment and evaluation of reclamation performance.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks (cont'd)				
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	January 7, 2015 Email	NGTL has considered AESRD's input and will complete a CHRP for the Project, which will supersede the CMP. As per AESRD's input, the construction start date at the proposed compressor station site has been altered to avoid the caribou timing restriction. The planned start date is now July 16, 2015. NGTL will use up to 8 m of temporary workspace over the existing pipeline ROW to reduce the Project footprint. The Project team is investigating opportunities to further reduce the permanent ROW. NGTL requested another meeting with J. Skilnick and E. Barnett.	4 5.1 5.6	Pre-construction planning considerations to reduce the Project footprint are discussed in Section 4. Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	January 30, 2015 Email	NGTL stated that the NEB issued an approval Order for the Project. Clearing and construction at the compressor station is scheduled from July 16, 2015 to April 1, 2016. Pipeline construction will start on September 1, 2015 as conditions allow and will continue into March 2015.	5.1 5.6	Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	February 2, 2015 Email	AESRD stated that it is their expectation that the timing restriction in caribou range be adhered to. AESRD will not be in favour of providing extensions for construction activities into this timing restriction.	5.1 5.6	Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks(cont'd)				
Ed Barnett Forest Officer Wandering River, AB	March 2, 2015 Meeting	NGTL provided a Project update indicating NEB approval and the caribou conditions (CHRP, OMP and CHROMMP) were discussed. NGTL provided recent details on the construction schedule. Use of timber for restoration measures was discussed and was confirmed as not being a concern. The applicability of the EAP guidelines to the Project and the ROW width were discussed.	5.1 5.6 4–6	Timing windows and scheduling are discussed in Sections 5.1 and Section 5.6. Pre-construction planning considerations to reduce the Project footprint are discussed in Section 4. Use of timber (coarse woody debris) is considered throughout the CHRP as a potential habitat restoration measure (particularly as it relates to rollback for access management).
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	March 26, 2015 Meeting	AESRD indicated they will not have time to comment on the Preliminary CHRP until end of April. AESRD mentioned in previous CHRPs they were not invited to comment. NGTL stated this is a condition for Project approval.	3.5.2.2., Appendix A, 2, 6.2, 4.5.1	This Preliminary CHRP incorporates feedback from previous CHRPs, consultation and AESRD review of the CMP.
		AESRD recommended the option of transplanting trees, creating vegetation screens every 200 m, which provides immediate restoration in black spruce areas, line-of-sight control and restores connectivity.	3.5.4, 6.1, 6.2.5	Transplanting native vegetation is not a suitable CHRP measure since it has been shown to be a difficult technique to implement on a large scale, with marginal results and multiple limitations. In forested areas of the Project footprint where sight lines are 500 m long or more, line-of-sight blocks will be established.
		AESRD recommened minimum disturbance and boring techniques. NGTL mentioned that these activities increase duration of construction. AESRD stated that the timing restrictions should not be used as an excuse not to minimize more impacts.	6.1, 4.4, 4.5	Minimum disturbance construction is a suitable CHRP measure, and will be implemented where scheduling and soil conditions (i.e., frozen) allow. NGTL is considering extending the length of bored crossings to retain vegetation screens though logistical constraints (e.g., alternate access, technology capacity, pipe requirements) might inhibit implementation of this measure.
		AESRD requested that NGTL coordinate with Grand Rapids on caribou habitat restoration treatments.	–	NGTL states commitment to working with Grand Rapids and sharing information to facilitate this.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks (cont'd)				
	March 26, 2015 Meeting (cont'd)	AESRD requested that NGTL talk to COSIA regarding provincial assessment of CHRPs/effectiveness published winter 2014/15. Offsets Management Plan: NGTL discussed the OMP condition from the NEB and asked if AESRD had any offset ideas. AESRD preference is for NGTL to restore habitat in the ESAR and on existing ROWs. AESRD would prefer NGTL spend money on minimizing and restoring, and then offsetting on own ROW or neighbouring ROWs. AESRD stated preference of 4:1 ratio.	3.5.2 1.2	Caribou habitat restoration initiatives, including COSIA, are described in Section 3.5.2 of the Preliminary CHRP. As per condition 7 outlined in NEB Order XG-N081-003-2015, NGTL will prepare a Preliminary and Final OMP, which will be filed under separate cover. The method used to calculate offset ratio will account for uncertainty and time lag.
	March 30, 2015 Email	NGTL provided AESRD with a Draft Preliminary CHRP for review and comment.	–	–
Joana Burgar Wildlife Biologist, on behalf of Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	June 17, 2015 Email	Ambiguous terms should be removed from the CHRP. Specify how mitigation measures criteria will be evaluated. EAP standards will be considered for this Project only if all EAP standards, guidelines and best management practices are considered, including Section 8: Wildlife, which states that in forested areas, line-of-sight should be limited to 200 m on non-roadway linear features. Until a detailed rationale for 500 m line-of-sight break is provided and deemed effective in mitigating impacts on caribou, target line-of-sight distance should be no greater than 200 m in forested segments. Provide rationale for natural revegetation vs active restoration. Concern about activity within the RAP and will not allow it if NGTL has not shown due diligence in completing work outside the RAP. AESRD plans status meetings with NGTL every two weeks during construction. Concerns about caribou mitigation measures during construction. AESRD recommended caribou monitoring project for duration of CHRP.	Throughout 5.1 5.4 6.3 5.2.1 Table 5-3 5.6 5.5	NGTL recognized this and has revised this CHRP to be more specific and clear in its approach. NGTL has provided rationale for the 500 m line-of-sight break. Active restoration (e.g., tree planting) will be promoted in areas where natural revegetation is not expected to achieve the quantifiable targets. NGTL is planning construction for outside the RAP and will update AESRD at biweekly meetings during construction. This section removed from the CHRP. NGTL will develop a Project CHROMMP that will span 15 years.

8.0 LITERATURE REVIEW

A literature review was conducted to provide regulatory and ecological context relevant to boreal caribou and specifically to the ESAR caribou range, including threats and management considerations for recovery of boreal caribou. This context provides an understanding of the current knowledge of the value and purpose of habitat restoration in caribou range.

In addition, available information on mitigation measures and habitat restoration methods was compiled and summarized in Section 5 and Appendix C. This summary was used to provide the foundation for the toolbox of measures available to NGTL to effectively mitigate potential Project effects on caribou and caribou habitat. Knowledge gaps that contribute to uncertainty in caribou habitat restoration are identified in Section 8.6. Based on the results of the literature review, the habitat restoration measures best suited for caribou range are identified.

8.1 LITERATURE REVIEW METHODS

The literature review incorporates regulatory and ecological context relevant to the ESAR caribou range to inform the selection of appropriate mitigation and habitat restoration measures. The key results from current boreal caribou literature as well as previous and ongoing habitat restoration initiatives, techniques implemented and their reported successes and failures were reviewed to inform the CHRP.

This methods section is provided to address Condition 6 of NEB Order XG-N081-003-2015. The literature review was completed using a systematic approach and standard research techniques, which enabled NGTL to consider the most recent published knowledge of caribou habitat restoration in the Preliminary CHRP. Sources reviewed include federal and provincial recovery strategies and management plans, previously submitted NGTL CHRPs, publically available government reports, in-house reference material and peer-reviewed journal articles. The literature review for the Preliminary CHRP included a systematic search of the following industry and scholarly databases for queried keywords and phrases:

- Google
- Google Scholar
- BioOne
- Web of Science
- Cumulative Environmental Management Association (CEMA) database, including Oil Sands Leadership Initiative (OSLI) historic filings

The following search terms were used in the literature review:

- caribou habitat restoration
- boreal caribou
- boreal forest and forested wetlands restoration
- linear corridor restoration/reclamation
- linear feature restoration in boreal forest and forested wetlands
- Alberta caribou recovery/range plan/policy/action plan

COSIA website (COSIA 2012) was searched to gather knowledge on current restoration measures, including the LiDea Project, the Algar Historic Restoration Project and OSLI environmental performance projects.

TERA, a CH2M Hill Company, attended the 15th North American Caribou Workshop (North American Caribou Workshop 2014), where several technical sessions related to habitat restoration for caribou were presented. Relevant information for CHRP planning related to use of rollback and monitoring wildlife use of restored linear features is summarized in the relevant sections of the literature review.

Caribou habitat restoration is receiving increasing research attention and it is anticipated that methods to restore habitat will continue to be tested and modified in the near future. NGTL will continue to incorporate this new information in the Final CHRP and post-construction monitoring.

8.2 REGULATORY POLICY, RECOVERY OBJECTIVES AND GUIDELINES FOR BOREAL CARIBOU

The Preliminary CHRP was developed considering current regulatory policies specific to boreal caribou. The identified regulatory policy and management documents considered to develop the Project CHRP include:

- *Alberta Woodland Caribou Recovery Plan, 2004/05 to 2013/14* (Alberta Woodland Caribou Recovery Team 2005)
- *A Woodland Caribou Policy for Alberta* (Government of Alberta 2011)
- federal *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* (Environment Canada 2012)

Further information on each of the documents listed above is summarized in the following paragraphs. NGTL began consultation and working collaboratively with provincial regulators, Aboriginal communities, stakeholders and industry partners in the early planning stages of the Project. NGTL will continue to work with provincial and federal regulators to align the CHRP measures with current provincial and federal policies.

The *Woodland Caribou Policy for Alberta* (Government of Alberta 2011) identifies recovery strategies that include maintenance and restoration of caribou habitat, establishment of range-specific habitat objectives, management of other wildlife populations (predators and primary prey), adaptive management, as well as legislative and social considerations. A key strategy adopted by the *Woodland Caribou Policy for Alberta* is the development of range-specific assessments and objectives (i.e., action plans), which builds on the work of previous recovery strategies, such as the *Alberta Woodland Caribou Recovery Plan 2004/05 – 2013/14* (Alberta Woodland Caribou Recovery Team 2005).

Similar to the provincial policy, the *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* (Environment Canada 2012) stresses the importance of landscape-level planning, such as planning development activities at appropriate temporal and spatial scales, incorporating caribou habitat requirements in fire management plans, establishing key protected areas and incorporating adaptive management. One of the management approaches suggested in the federal recovery strategy to address effects of habitat alteration on boreal caribou is to undertake coordinated actions to reclaim boreal caribou habitat through restoration efforts. This might include restoration of industrial features such as roads, seismic lines, pipelines, cut lines and clearings (Environment Canada 2012). The Preliminary CHRP adopts the definition of caribou habitat provided in the Recovery Strategy (i.e., habitat in defined caribou ranges that is necessary to maintain or recover self-sustaining local populations throughout their distribution).

NGTL is continuing to work with AESRD to align the CHRP measures with the provincial caribou policy and the future provincial Caribou Action Plan for the ESAR caribou range. Range-specific Caribou Action Plans are required as part of the province's commitment to the proposed federal Recovery Strategy. A range-specific assessment or recovery plan for the ESAR caribou range has not yet been developed by the province.

The goal of the *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* is to achieve self-sustaining local populations in all boreal caribou ranges throughout their current distribution in Canada, to the extent possible (Environment Canada 2012). The Recovery Strategy applies to the ESAR caribou range. Population and distribution objectives identified in the Recovery Strategy include, to the extent possible:

- maintain current status of the 14 existing self-sustaining local populations
- stabilize and achieve self-sustaining status for the 37 non-self-sustaining local populations (a group that includes the ESAR caribou range)

The federal Recovery Strategy identifies critical habitat for the boreal woodland caribou as:

- the area within the boundary of each caribou range that provides an overall ecological condition that will allow for an ongoing recruitment and retirement cycle of habitat, which maintains a minimum of 65% of the area as undisturbed habitat
- biophysical attributes required by boreal caribou to carry out life processes (Environment Canada 2012)

Therefore, the habitat threshold that provides a measureable probability for a local caribou population to be self-sustaining is considered to be 65% undisturbed habitat in the range (Environment Canada 2012).

In addition to the recovery planning and policy documents described above, NGTL considered the *Integrated Standards and Guidelines – Enhanced Approval Process* (Alberta Energy Regulator [AER] 2013) to develop caribou-specific mitigation measures. These standards and guidelines identify desired outcomes, which include:

- reduction of human-caused direct mortality associated with linear features
- excessive predator-caused mortality
- habitat loss
- partial avoidance demonstrated by caribou in relation to industrial features
- increases in distribution and productivity of other prey species

Approval standards are specified, as are best management practices.

8.3 BOREAL WOODLAND CARIBOU ECOLOGY

As previously mentioned, the boreal population of woodland caribou is listed as Threatened on Schedule 1 of *SARA*, by COSEWIC and under the Alberta *Wildlife Act* (AESRD 2014a; COSEWIC 2015; Environment Canada 2015).

Woodland caribou in Alberta are found in bogs and fens with low to moderate tree cover and tend to avoid marshes, uplands, heavily forested wetlands, water and areas of human use (Thomas and Gray 2002). Local caribou population ranges encompass areas large enough for all life processes (calving, rutting, wintering). Therefore, woodland caribou require large tracts of continuous undisturbed habitat, as they disperse when calving to reduce predation risk (Vistnes and Nellemann 2001; Environment Canada 2011). Preferred habitat is typically mature coniferous forest (e.g., jackpine and black spruce) with abundant lichen, muskeg and peatlands intermixed with upland or hilly areas (Brown, Huot et al. 1986; Bradshaw et al. 1995; Stuart-Smith et al. 1997; Neufeld 2006; O'Brien et al. 2006; Brown, Rettie et al. 2007; Rettie and Messier 2000; Courtois and Ouellet 2007).

Sufficient canopy cover or wind-exposed areas are required to keep snow depth at low enough levels to allow foraging (LaPerriere and Lent 1977; Collins and Smith 1991; Schaefer and Pruitt 1991).

Boreal woodland caribou do not undergo seasonal migrations and remain in forest and peat habitats throughout the year (Alberta Woodland Caribou Recovery Team 2005). Forested peat complexes are the primary habitat for boreal caribou and they require large contiguous tracts of this preferred habitat to maintain low population densities across their range as an anti-predator tactic (Alberta Woodland Caribou Recovery Team 2005). Boreal caribou maintain spatial separation from other ungulates by occupying habitat that has a lower density of other ungulate species (Alberta Sustainable Resource Development [ASRD] and Alberta Conservation Association [ACA] 2010).

The rutting season occurs in early to mid-October, and caribou have a gestation period of approximately 7.5 to 8 months. In northern Alberta, most calves are born in the first two weeks of May (ASRD and ACA 2010).

Compared with other forest-dwelling ungulate species, woodland caribou exhibit low reproductive potential. Adult cows are typically three years old before they begin producing young and only produce a single calf annually (ASRD and ACA 2010).

The ESAR caribou range is located east of the Athabasca River, and includes seven small populations of caribou that are largely independent from each other: Algar, Egg–Pony, Agnes, Wandering, Wiau, Bohn and Christina (ASRD and ACA 2010). Radio-telemetry data indicate that very little movement occurs between caribou ranges (ASRD and ACA 2010). The Project is located in the Egg-Pony and Algar ranges.

Estimated caribou population size in the ESAR caribou range is 90 to 150 individuals and the population trend is declining (Environment Canada 2012). The ESAR caribou range is 1,315,980 ha in area (Environment Canada 2012). The population growth for the ESAR caribou range was 0.81 in 2007/2008, with calf recruitment between 12.6 and 16.1 calves per 100 cows. A total of 116 caribou were observed in the ESAR caribou range during the 2008 caribou/calf surveys. The population of the ESAR caribou range was stable to declining between 1992/1993 and 1999/2000, but has consistently declined since (Athabasca Landscape Team 2009). Environment Canada (2012) reports that 81% of the ESAR caribou range is affected by anthropogenic and fire disturbance, which exceeds the threshold level of disturbance (35%) that will support a self-sustaining caribou population.

8.4 THREATS AND LIMITING FACTORS

Threats to boreal woodland caribou identified by the federal Recovery Strategy (Environment Canada 2012), in descending order of direct impact on caribou population trend, are:

- predation
- habitat alteration from human land-use activities
- natural disturbance of habitat
- hunting
- climate change and severe weather

Other threats considered to have a lower level of concern include parasites and disease, stress responses associated with sensory disturbance (noise and light), vehicle collisions and pollution.

Available literature supports apparent competition as the likely causal pathway for woodland caribou population declines, whereby primary prey species (e.g., moose, deer) increase with increasing proportions of early seral habitat on the landscape, causing a numerical response of predators (COSEWIC 2002; Environment Canada 2012; Latham 2009; Seip and Cichowski 1996; Wittmer et al. 2005). Wolves are considered the primary predators of caribou across northern Canada and predation by wolves was implicated as the most common cause of death for adult caribou in northeastern Alberta (McLoughlin et al. 2003). Black bear can also be a common predator of caribou (Rettie and Messier 1998; Zager and Beechman 2006).

Increases in predator numbers subject caribou to unsustainable levels of predation, causing population decline (Wittmer et al. 2005). Predator densities capable of causing caribou declines are usually sustained by abundant alternate prey sources, such as moose or white-tailed deer (COSEWIC 2002; Peters et al. 2013; Wittmer et al. 2005). Predation on caribou is thought to be largely incidental, given the low densities of woodland caribou compared with much more abundant prey species (Wittmer et al. 2005).

The primary selection of peatlands and old-growth forest by caribou, and lack of positive habitat selection non-use of these areas by moose, wolves (Rettie and Messier 2000) and black bears (Latham et al. 2011) was determined to result in spatial separation (James et al. 2004). This strategy is believed to be used to combat the widespread influence that wolves have in an ecosystem (Ripple and Beschta 2004; Ripple et al. 2014). Removal or alteration of habitat (e.g., forest harvesting [McCutchen 2007]) will dissolve what spatially separates caribou and primary prey (i.e., moose). Following forest harvest, moose and woodland caribou were more likely to use the same habitat, and woodland caribou suffered higher rates of wolf predation (Peters et al. 2013).

The influence of anthropogenic linear feature density on predation rates might be equally as important to caribou mortality as the density of predators (Whittington et al. 2011). The ultimate cost to caribou habitat suitability appears lower for linear feature-induced changes compared with forestry-induced (i.e., cutblocks) changes (DeCesare et al. 2012). Linear feature-induced changes have been previously linked to changes in predator functional response (predator kill rate) while forestry-induced changes have been previously linked to changes in predator numerical response (predator density).

Evidence shows scale-dependent variation in caribou resource selection, where habitat selection at the population and individual seasonal home range scale is affected by forestry cutblocks (DeCesare et al. 2012). Forestry cutblocks are linked to increased predator densities (Latham et al. 2011). Conversely, caribou distribution is shown to be strongly influenced by linear disturbance at the finer (location-level) scale (DeCesare et al. 2012).

Linear corridors provide improved access for predators such as wolves. Several studies have found that linear corridors are attractive to bears (McKay et al. 2014) and especially wolves as easy travel routes (James 1999; James and Stuart-Smith 2000; Stuart-Smith et al. 1997; Thurber et al. 1994; Whittington et al. 2011). As a result, linear disturbances can influence predator/prey dynamics (Bergerud et al. 1984; Edmonds and Bloomfield 1984; Rohner and Kuzyk 2000). Wolves travel faster along linear disturbances (James 1999; McKenzie et al. 2012) and encounter rates between wolves and caribou have been shown to increase near linear features (Whittington et al. 2011).

Furthermore, it is suggested that while wolves increase movement rates on linear disturbance features, their movement rates decrease in proximity to disturbance features. This implies behaviour closely associated with prey searching and hunting (Ehlers et al. 2014). However, modelling the dynamic use of the landscape by wolves, primary prey (moose) and caribou showed that wolves experience no additional advantage accessing caribou from linear features, although they do benefit in accessing primary prey species (McCutchen 2007). This is supported by a study that found that kill sites were no closer to linear features than random (Latham et al. 2011).

Caribou are sensitive to anthropogenic disturbance (e.g., industrial activity [Dyer et al. 2001, 2002]) and habitat alteration (e.g., forestry [Peters et al. 2013]), and to natural disturbance (e.g., burns [Schaefer and Pruitt 1991]). Long-term reduction in habitat effectiveness adjacent to linear features can occur as caribou have been shown to partially avoid habitats near ROWs (Dyer 1999; Oberg 2001). Avoidance of habitat near anthropogenic disturbances leads to indirect habitat loss through reduced habitat effectiveness for caribou (Dyer et al. 2001).

Methods and study populations vary among research studies that demonstrate caribou avoidance of disturbances by varying distances: 70 m (seismic lines and maintained trails [DeCesare et al. 2012]), 250 m (roads and seismic lines [Dyer et al. 2001]) and 1,000 m (industrial developments such as well sites [Dyer et al. 2001]). The federal Recovery Strategy for boreal caribou defines disturbance of critical habitat as the area affected by human-caused disturbance, including a 500 m buffer around the disturbance to account for avoidance by caribou, and the area affected by fire less than 40 years old (Environment Canada 2012).

Restoration of disturbance assumes that caribou will return to being spatially separated from primary prey (moose, deer) and predators, and hence natural levels of mortality risk (Athabasca Landscape Team 2009). Management of boreal caribou habitat to maintain viable populations over time will require both minimizing the impact of future development and recovery of the existing industrial footprint.

Woodland caribou populations are very low in many areas and, therefore, populations simply might not rebound due to increasing rates of inbreeding and other, well-defined detrimental effects of genetic drift that are characteristic of small, genetically isolated populations (Bijlsma et al. 2000; Frankham 2005; Hedrick and Kalinowski 2000; Keller and Waller 2002). This phenomenon, known as the Allee effect, was recently suggested to likely occur in the boreal population of woodland caribou in Alberta (Hervieux et al. 2013; Serrouya et al. 2012).

8.5 CARIBOU RECOVERY AND HABITAT RESTORATION

The lowland habitat types naturally have very slow rates of vegetation establishment and growth, making tree seedling establishment and growth in a 15-year period unpredictable. Guidelines for wetland restoration associated with oil sands mining (AENV 2008) focus on disturbance types that are not applicable to pipeline construction and operation. Furthermore, reclamation of bogs and fens (i.e., the treed lowland and shrubby/graminoid lowland habitat types addressed in this CHRP), is in experimental stages and is not addressed in the current guidelines. The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* includes specifications for various indicators using an “end land use” approach that targets reclamation to commercial forests, which conceptually provide other ecosystem functions including wildlife habitat (AENV 2010).The application of these guidelines to the CHRP needs to be approached with caution, since they relate to a very different disturbance type (i.e., bitumen mining vs. pipeline ROW) and are developed for different objectives.

With these limitations in mind, it is recognized that the AENV guidelines for oil sands reclamation are developed for boreal forests with similar attributes to those on the Project and, therefore, some of the thresholds and indicators were used to guide the development of quantifiable targets for the CHRP.

In particular, the quantifiable targets associated with treed lowland and shrubby/graminoid lowland habitat types incorporated the concept of plant community composition as an appropriate indicator to assess reclamation status and progress (AENV 2010). This is supported by the suggestion that the number and abundance of characteristic species (i.e., species typically found in undisturbed native wetland plant communities) and the number of restricted weeds are measures for plant community health (Cibrowski et al. 2012).

Plant community composition as described in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010) and characteristics of healthy plant communities in treed lowlands were used to develop quantifiable targets for the lowland habitat types in this CHRP. A threshold of two characteristic species in wet poor sites is suggested, which was derived to be conservative (low) with respect to realistic achievement of thresholds (AENV 2010). This species threshold was determined based on data from reclaimed oil sands 20 or more years after reclamation (AENV 2010). Given the much lower disturbance level associated with pipeline construction and operation compared with oil sands mining, three characteristic species within the 15-year monitoring period is likely a reasonable quantifiable target and has been adopted for restoration of the lowland habitat types in the Preliminary CHRP (see Table 4-1). Characteristic species can include vascular and non-vascular plants, provided they are species found in the adjacent undisturbed native plant community. The other quantifiable targets for lowland habitats are absence of restricted weeds to indicate vegetation community health and 80% vegetation cover by characteristic species. Quantifiable targets are also provided in Table 4-1 for lowlands where conifer seedlings are planted in mounded sites.

There are no existing specifications for design and implementation of caribou habitat restoration measures. As a result, restoration criteria and guidelines for forested areas in Alberta and reforestation standards in Alberta specific to the Project area (Alberta Environment [AENV] 2001, 2008, 2010; AESRD 2013b,c, 2014b) were used to develop appropriate specifications for the CHRP restoration measures.

A common approach in reclamation of forested land in Alberta is the application of provincial standards developed to achieve equivalent land capability to support target end land uses, often with a focus on merchantable forest stands (e.g., AENV 2010; AESRD 2013b). In relation to oil sands mining in northeastern Alberta, Straker and Donald (2011) and Hawkes (2011) have suggested that current reclamation standards might not be suitable where there is a broader set of management objectives such as maintenance of biodiversity, creating functional forest ecosystems or restoration of species-specific wildlife habitat.

The Reclamation Assessment Criteria for Pipelines (AENV 2001) recommends that equivalent land capability should take into account natural variability, which considers the range of landscape attributes that are encountered and influenced by slope, drainage, coarse fragments, vegetation growth and composition, and soil color, texture, aggregate strength and size.

The *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (AENV 2008) focuses on disturbance types that are not applicable to pipeline construction and operation. Furthermore, reclamation of bogs and fens (i.e., the treed lowland and shrubby/graminoid lowland habitat types addressed in this CHRP), is in experimental stages and is not addressed in the current guidelines.

The *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* (AESRD 2013b) provides reclamation criteria that apply to well site leases and access roads, and associated facilities such as pits, campsites and offsite sumps. Criteria are provided to determine whether a reclaimed site meets equivalent land capability, based on function and operability of the land to support the production of goods and services consistent in quality and quantity with the surrounding landscape. A minimum 25% cover of herbaceous and of woody species is recommended for naturally regenerating and planted sites in forested lands. The document suggests that ecosystem function can be determined when natural processes are evident, such as proper drainage, moisture retention and cycling, soil and site stability, and nutrient cycling (i.e., litter formation). Recommendations for assessing reclamation success are provided for various factors such as drainage, erosion, soil stability, woody debris, plant community composition and cover, litter and LFH development, and soil characteristics.

The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* includes specifications for various indicators using an “end land use” approach that targets reclamation to commercial forests (AENV 2010). In concept, commercial forests also provide other ecosystem functions. The application of these guidelines to the CHRP needs to be approached with caution, since they relate to a very different disturbance type (i.e., bitumen mining vs. pipeline ROW) and are developed for different objectives. The *Alberta Regeneration Standards for the Mineable Oil Sands* (AESRD 2013c) are similarly applicable to reforestation of oil sands mines. The standards outline protocols for establishment and performance surveys to determine reforestation establishment and continued growth, where commercial forestry is the end land use. Seedling planting or target densities are not specified. The standard does, however, provide guidance on determining “poorly revegetated areas” based on the size (≥0.5 ha) and proportion (≥25%) of trees affected by mortality, foliage loss/discolouration, missing or low density, physical damage, or poor form or vigour.

The *Reforestation Standard of Alberta* (AESRD 2014b) specifies that openings (i.e., cutblocks) are considered sufficiently regenerated if 80% or more of area contains acceptable tree regeneration. Regeneration is assessed by tree characteristics including species composition and density, spatial distribution, height, well-defined stems and damage. The standards are intended for reforestation of commercially harvested forests, with the intent of regenerating commercially viable forests.

8.6 VEGETATION REESTABLISHMENT

Restoration of disturbed habitat has become one of the key components for caribou conservation identified through the federal Recovery Strategy (Environment Canada 2012) and in provincial boreal caribou recover planning (Alberta Woodland Caribou Recovery Team 2005; Government of Alberta 2011). This section summarizes information from habitat restoration guidelines, previous caribou habitat restoration initiatives, and published research. Information on restoration methods employed and effectiveness or success of restoration is included. This section is supplemented with information specific to restoration initiatives already completed in boreal woodland caribou range (see Appendix C), which was considered as context in Preliminary CHRP development.

8.6.1 Tree Planting and Natural Regeneration

Recent research has shown positive results for establishing native vegetation on seismic lines and other linear features using techniques such as planting tree and shrub seedlings, and site preparation to create microsite conditions (i.e., tree planting methods) that are conducive to both planted seedling growth and natural vegetation encroachment (CRRP 2007b; COSIA 2012). Measures such as rollback can address site condition issues, including competition from non-target or undesired plant species, erosion, frost, and heat or moisture deficiencies (CRRP 2007b). These methods are consistent with the approach adopted by NGTL in previous CHRPs.

Natural revegetation and successful planting initiatives benefit from construction practices that minimize disturbance during development of the footprint. Minimum disurbance pipeline construction techniques that avoid grubbing and grading are effective at facilitating rapid regeneration of native vegetation in the ROW, in particular in areas with a deciduous vegetation component (TERA 2011a,b, 2012). Implementation of minimum disturbance construction can be limited by such factors as terrain that requires grading, ground conditions (e.g., non-frozen soils) and construction methods (e.g., crossings of third-party dispositions).

A trial natural revegetation response inventory program in west-central Alberta reported that 85% of disturbed sites did not require artificial recovery, since a natural recovery projection was observed on previously disturbed sites (CRRP 2007c).

Although regenerating conifers provide a better visual barrier, the faster growth rates of deciduous species provides for effective results more quickly (Diversified Environmental Services [DES] 2004). Recent research suggests that planting shrubs along with trees allows trees to grow healthier, faster and with less competition for nutrients and water from fast-growing grasses (COSIA 2012). It might also provide important habitat benefits for wildlife, compared with only planting tree seedlings, by providing hiding cover (Bayne et al. 2011).

Conventional seismic lines have been reported to have very slow reforestation rates (Revel et al. 1984; Osko and MacFarlane 2000), and recovery is strongly influenced by the characteristics of the adjacent forests (e.g., site productivity, tree and shrub species and heights) (Bayne et al. 2011). Conventional seismic lines cleared by bulldozer can take as long as 112 years to reach 95% recovery to woody vegetation in the absence of restoration efforts (Lee and Boutin 2006). Slow tree regeneration has been attributed to root damage from the original disturbance, compaction of the soil in tire ruts, insufficient light reaching the forest floor, maintenance of apical dominance from surrounding stands, introduction of competitive species (i.e., planted seed mixes), site drainage (i.e., regeneration slowest on poorly drained sites with low nutrient availability such as bogs) and repeated disturbances (e.g., all-terrain vehicles [ATVs], animal browsing, repeated exploration) on seismic lines (Revel et al. 1984; MacFarlane 1999, 2003; Sherrington 2003; Lee and Boutin 2006). However, tree regeneration on seismic lines is a key determinant of recovery success (MacFarlane 2003) and, therefore, factors that hinder revegetation efforts should be mitigated. Although seismic lines and pipeline ROWs are both linear disturbances, drawing parallels between regeneration success on these different features should be done with caution. Restoration issues on seismic lines might not be comparable to pipeline ROWs, given differences in disturbance mechanisms, degree of soil and vegetation disturbance, reclamation practices and width of the features (i.e., the wider openings of ROWs allow more light and insolation than narrow seismic lines, which might facilitate better vegetation regrowth).

Evidence presented at the 15th North American Caribou Workshop demonstrated winter tree planting and mechanically bending live trees into the ROW are emerging mitigation options that are currently being implemented in the Alberta oil sands region (North American Caribou Workshop 2014). Tree bending might be particularly promising as it promotes natural revegetation by increasing cone deposition onto the disturbance footprint and creating microsites through shading and dropped dead woody debris. However, these mitigation measures are only initially being evaluated and their utility remains unknown. Furthermore, they were applied on seismic lines that are substantially narrower than pipeline ROWs and do not require continued operation activities, as do pipelines.

8.6.2 Transplanting and Seeding

Transplanting native vegetation appears to be difficult to implement on a large scale as part of a habitat restoration program for the following reasons (Golder 2012a):

- inconsistent availability of vegetation suitable for transplant
- potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands
- transplanting programs often result in the storage of plant materials under less-than-ideal conditions due to uncontrollable factors (i.e., weather)
- other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison

An alternative to salvage and transplanting vegetation is to seed disturbed areas using seed collected from the same geographic region as the restoration project. Broadcasting seed either aerially or using ground methods (by hand or mechanically) is also an option. However, since pipeline ROWs are relatively narrow openings (compared with cutblocks, for example), sufficient natural seed ingress from the adjacent undisturbed habitat can facilitate natural recovery without additional seed application. Logistically, the feasibility of seeding can be constrained where the reclamation project is a substantial distance from an airport or airfield (i.e., for aerial seeding), or where ground access during non-frozen conditions is restricted by wet soils. Furthermore, direct seeding of conifers is not a preferred reforestation technique, partly due to problems with seed predation (British Columbia Ministry of Forests 1997).

8.7 EFFECTS OF HUMAN USE ON RESTORATION

The ability of linear features to recover to a natural forested state is affected considerably by human use. Recovery of conventional seismic lines to functioning mountain caribou habitat occurs was identified to be within 20 years following disturbance in west-central Alberta (Oberg 2001).

Seismic lines in the Little Smoky caribou range that were allowed to revegetate naturally reportedly achieved an average height of 2 m across all ecosite types, within 20 to 25 years, when they had not been recently disturbed by human activity (e.g., re-cleared to ground level for winter access or seismic program use [Golder 2009]). The average age of trees on the control lines was only 10 years, suggesting sites that are continually disturbed or re-cleared by human activity take longer to regenerate.

Restoration efforts have also failed when ATVs destroyed seedlings after planting (Enbridge 2010; Golder 2011, 2012b). Evidence of the effects of repeated motorized access on vegetation establishment and regrowth supports the use of access management tools to enhance restoration success.

Subjective expert ratings suggest that the effectiveness of most physical access management measures (e.g., berms, excavations, rollback, visual screening) varies considerably between negligible and high effectiveness in managing human access (Golder 2007). Effectiveness of access management measures likely depends on suitable placement (e.g., placed to prevent detouring around an access management point), enforcement and public education of the intent of the access management (AXYS Environmental Consulting Ltd. [AXYS] 1995). Public education (e.g., signs) facilitates respect for the purpose of, and compliance with, access management measures.

Mounding has been found to discourage human access (i.e., truck and ATV) during snow-free periods and also creates microsites that improve vegetation establishment (review in Golder 2007). Excavator mounding is a well-researched and popular site preparation technique in the silviculture industry (Macadam and Bedford 1998; Roy et al. 1999; MacIsaac et al. 2004). Target density of mounding for access management and/or microsite creation purposes can vary from 1,400 to 2,000 mounds/ha (AENV 2010; Golder 2012a). However, these mound densities relate to restoring seismic lines that were not frozen-in to allow heavy equipment access. Given the challenges of the wet conditions and frost requirements for accessing the Project footprint (i.e., freezing-in the peat for access can make it difficult to excavate small mounds), the size of mounds could potentially be substantially larger than mounds achieved on previous seismic line restoration projects. Furthermore, mounds cannot be excavated within 5 m of the operating pipeline, which reduces the mound density relative to disturbances that do not have similar restrictions. As a result, the mound density that can realistically be achieved in pipeline ROWs is lower.

Human access on open and closed (i.e., gated, barriered and recontoured) roads was monitored using remote cameras (Switalski and Nelson 2011). That study found that the frequency of detection of humans on closed roads was significantly lower than on open roads, but not significantly different among road closure types. The monitoring results also indicated significantly higher levels of hiding cover and lower line-of-sight distances on barriered and recontoured roads compared with open roads (Switalski and Nelson 2011). A similar study investigated the effectiveness of different approaches (i.e., year-round closure, seasonal closure, deactivation, and deactivation and closure) at limiting motorized vehicle traffic on unpaved roads designed to support forestry operations (i.e., resource roads) (Hunt and Hupf 2014).

Results demonstrated that closure and/or deactivation approaches significantly reduced traffic on resource roads (about 78%), with year-round closure being the least effective while seasonal (i.e., hunting) closure being among the most effective approach (Hunt and Hupf 2014). The effectiveness of different approaches did not depend on road quality (Hunt and Hupf 2014). Physical access management measures provide short-term solutions to manage access and allow for natural regeneration (Golder 2009). Once linear features have regenerated to a pole sapling or young forest structural stage, they no longer facilitate ATV access (Sherrington 2003).

The techniques described above to block human access also contribute to achieving sufficient revegetation to block line–of–sight. Short-term management for access and line-of-sight blocking should ultimately lead to long-term access management by way of revegetation of disturbed areas (Golder 2007). Expediting growth of visual barriers along linear features can be achieved by concentrating restoration efforts on productive upland habitats, since woody vegetation species grow more quickly on these sites compared with lowland sites. Although regeneration of conifer species provides the best year-round visual barrier, their growth can be slow. Using combined plantings of conifer and fast-growing deciduous woody species in small areas (e.g., narrow strips of plantings across the ROW) can establish visual barriers in the short to medium term, while maintaining the objective of regenerating conifer-leading vegetation in the long term.

Coarse woody material (rollback) can be effective to manage human access as well as to conserve soil moisture, moderate soil temperatures, provide nutrients as debris decomposes, limit soil erosion, provide microsites for seed germination and protection for introduced tree seedlings (Pyper and Vinge 2012; Vinge and Pyper 2012). Rollback is effective immediately following implementation, provided adequate material is available and properly applied. Debris should be spread evenly across the entire footprint width at a coverage/density that will not restrict ability to plant seedlings or limit planted or natural seedling growth. Where sufficient material is available, the suggested woody debris coverage at selected locations is 60-100 m^3/ha on upland sites and 25-50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012). Where sufficient material is available, woody debris coverage of 150-200 m^3/ha along ROWs can be used to manage human and wildlife access (Vinge and Pyper 2012). The storage and placement of woody debris must consider reducing ladder fuels to reduce fire hazard (Pyper and Vinge 2012). Short segments (i.e., <100 m) of rollback might be less effective at deterring human access because ATV and snowmobile riders might try to ride through the debris or traverse around it in adjacent forest stands (Vinge and Pyper 2012). Complete rollback (i.e., over an entire linear disturbance) could be used to prevent motorized access (Pyper and Vinge 2012), however, availability of material is a limiting factor. The *Integrated Standards and Guidelines for the Enhanced Approval Process* recommend a 25 m rollback-free fuel break be placed every 250 m along segments of rollback (AER 2013).

8.8 WILDLIFE USE OF REGENERATING LINEAR DISTURBANCE

While there has been some effort to assess wildlife use of regenerating seismic lines (e.g., Bayne et al. 2011) and reclaimed areas in the Athabasca oil sands region (e.g., Hawkes 2011), few researchers have assessed natural habitat recovery and wildlife responses to recovery with respect to caribou. A pilot study in the Little Smoky caribou range measured effects of revegetating linear disturbances on wildlife use and mobility (Golder 2009). Data were collected for a group of predators (i.e., cougar, wolf, coyote, lynx, grizzly and black bears) and prey (i.e., moose, deer and caribou). Results of the pilot study indicated that revegetated seismic lines (i.e., minimum 1.5 m vegetation regrowth) were preferred by both predator and prey species compared with control lines (i.e., vegetation regrowth of 0.5 m or less), and control lines were used primarily for travel (i.e., both predators and prey species were constantly moving as opposed to standing or foraging).

In addition, human use was almost exclusively limited to the control lines. The line-of-sight measured on the revegetating lines was typically less than 50 m long. It was suggested that moose and deer might have been attracted to the revegetated lines for forage availability and perceived cover protection (Golder 2009). The preference for regenerating seismic lines by wolves can be explained as a response to increased prey use of these lines (Golder 2009). The study also showed that caribou travelled more quickly (running more frequently) and did not engage in standing-related behaviour on control lines, whereas on revegetating lines, running was rare and standing-related behaviour occurred more often.

Another ongoing project in northern Alberta involving the Cold Lake caribou herd is currently investigating the responses of predator and prey species to the deactivation or restoration of habitat disturbance features (McNay et al. 2014). The goal of the project is to determine how different species (wolves, bears, moose and caribou) use the landscape, and how the presence or absence of linear disturbances might influence the functional and numerical response of predators (McNay et al. 2014). The project is still in the early stages. Preliminary results suggest that among all species seasonal and annual movements are variable, with substantial overlap between the range extents of all four species. Additionally in these range overlaps, were 19 instances where predator and prey could have encountered one another. Furthermore, preliminary results present 11 deaths of 94 collared animals: 2 caribou, 3 moose, 1 bear and 5 wolves. Predator kill sites identified included 143 bear sites and 93 wolf sites. These kill sites were implicated in the deaths of 11 caribou, 22 moose and 6 deer. Ongoing data collection and processing will provide future results from scat analysis, prey body condition, habitat modelling and mapping.

The project aims to address several management questions regarding the desired vegetative and spatial characteristics on the landscape to reduce caribou mortality, how silvicultural techniques and mitigation measures can be implemented to achieve these characteristics, the association between specific characteristics and predator efficiency and/or density, and when deactivated linear features can be considered to have lost their disturbance function (McNay et al. 2014). This project is associated with the RICC initiative.

Mechanically bending or felling live trees over a linear disturbance (often referred to as line-blocking, particularly when used in conjunction with other treatments such as mounding) is another potential measure that might have benefits for managing access and reducing wolf use. Trees are typically bent or felled from both sides of the linear disturbance. Tree felling entails cutting trees at the base from the edge of the linear disturbance, and allowing them to fall across the linear disturbance.

Tree bending requires mechanically bending from the base of the tree, partially exposing roots, so that the tree leans over the linear feature, close to the ground. Tree bending can be expensive and the process is time consuming. A preliminary assessment of tree felling along seismic lines to block access was completed in the Little Smoky herd range in Alberta during summer and fall 2004 (Neufeld 2006). While results of that study showed no statistical significance between wolf use of blocked versus non-blocked seismic lines, there was an indication that wolves tended to use areas with unblocked seismic lines more often than areas with blocked seismic lines (Neufeld 2006).

Based on these results, it was concluded that if tree felling is to be used as a line-blocking measure, it should be investigated more thoroughly, and not relied on solely as a mitigation tool (Neufeld 2006). Preferably, line-blocking should be used with other management actions such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. As previously described, tree felling or bending is often completed in conjunction with other measures, such as mounding, spreading coarse woody debris or seedling planting to achieve line-blocking.

As presented at the 15th North American Caribou Workshop, preliminary results of linear feature blocking programs suggest that this type of mitigation can be effective in reducing wildlife use of linear features (North American Caribou Workshop 2014).

8.9 KNOWLEDGE GAPS AND LIMITATIONS OF THE LITERATURE REVIEW

The literature review provided the opportunity to identify the following knowledge gaps:

- restoration criteria (e.g., defined guidelines or quantifiable objectives) for restoration of boreal ecosystems for wildlife habitat values, in particular habitats that do not support merchantable timber (e.g., treed bogs and fens)
- functional responses of caribou, wolves and primary prey (e.g., moose, deer) to reclaimed habitats in various stages of successional progression, as well as to access and line-of-sight management
- long-term monitoring of vegetation recovery on linear disturbances and of predator response to access management measures

9.0 REFERENCES

9.1 TEXT REFERENCES

Alberta Energy Regulator. 2013. *Integrated Standards and Guidelines*. Enhanced Approval Process (EAP). Effective: December1, 2013. Edmonton, AB. 94 pp.

Alberta Environment and Sustainable Resource Development. 2012. *Caribou Protection Plan Guidelines and Caribou Calving Information*. Edmonton, AB. 3 pp.

Alberta Environment and Sustainable Resource Development. 2013a. *Caribou Protection Plan (CPP) Submission Requirements for Winter 2013/14*. Industry Bulletin. October 2013. Edmonton, AB. 2 pp.

Alberta Environment and Sustainable Resource Development. 2013b. 2010 *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (Updated July 2013)*. Edmonton, AB. 81 pp.

Alberta Environment and Sustainable Resource Development. 2013c. *Alberta Regeneration Standards for the Mineable Oil Sands*. Government of Alberta, Department of Environment and Sustainable Resource Development. Edmonton, AB. 71 pp.

Alberta Environment and Sustainable Resource Development. 2013d. *Alberta Wildlife Animal Care Committee Class Protocol 013*. July 2013. Edmonton, AB. 3 pp.

Alberta Environment and Sustainable Resource Development. 2014. *Species Assessed by Alberta's Endangered Species Conservation Committee*. Updated July 4, 2014. Fish and Wildlife Policy Branch. Edmonton, AB. 2 pp.

Alberta Environment and Sustainable Resource Development. 2014b. *Reforestation Standard of Alberta*. Government of Alberta, Department of Environment and Sustainable Resource Development. Edmonton, AB. 264 pp.

Alberta Environment. 2001. *Reclamation Assessment Criteria for Pipelines – 2001 Draft*. Edmonton, AB. 70 pp. + Appendices.

Alberta Environment. 2008. *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases, 2nd Edition*. Prepared by M.L. Harris of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, AB. 103 pp. + Appendices.

Alberta Environment. 2010. *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition*. Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, AB. 332 pp.

Alberta Sustainable Resource Development and Alberta Conservation Association. 2010. *Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta: Update 2010*. Wildlife Status Report No. 30. Alberta Sustainable Resource Development. Edmonton, AB. 88 pp.

Alberta Woodland Caribou Recovery Team. 2005. *Alberta Woodland Caribou Recovery Plan 2004/05-2013/14.* Alberta Species at Risk Recovery Plan No. 4. Alberta Sustainable Resource Development, Fish and Wildlife Division. Edmonton, AB. 48 pp.

Athabasca Landscape Team. 2009. *Athabasca Caribou Landscape Management Options Report*. 75 pp. + Appendices.

AXYS Environmental Consulting Ltd. 1995. *A Compendium of Physical Access Control Measures for Roads and Other Rights-of-Way*. A Component of the Access Management Initiative in Northeastern BC.

AXYS Environmental Consulting Ltd. 2003. Appendix 13D.C *Access Management Plan. Ekwan Pipeline Project Environmental Protection Plan*. Prepared for EnCana Ekwan Pipeline Inc. Calgary, AB.

Bayne, E.M., H. Lankau and J. Tigner. 2011. *Ecologically Based Criteria to Assess the Impact and Recovery of Seismic Lines: The Importance of Width, Regeneration and Seismic Line Density*. Environmental Studies Research Funds Report No. 192. Edmonton, AB. 98 pp.

Bergerud, A.T., H.E. Butler and D.R. Miller. 1984. Antipredator tactics of calving caribou: Dispersion in mountains. *Canadian Journal of Zoology* 62: 1566–1575.

Bijlsma, R., J. Bundgaard and A.C. Boerema. 2000. Does inbreeding affect the extinction risk of small populations? Predictions from *Drosophila*. *Journal of Evolutionary Biology* 13(3): 502–514.

Bradshaw, C.J.A., D.M. Hebert, A.B. Rippin and S. Boutin. 1995. Winter peatland habitat selection by woodland caribou in northeastern Alberta. *Canadian Journal of Zoology* 73: 1567–1574.

British Columbia Ministry of Environment. 2011. *Interim Operating Practices for Oil and Gas Ac tivities in Identified Boreal Caribou Habitat in British Columbia*. September 22, 2011. Website:http:/ /www.env.gov.bc.ca/wld/speciesconservation/bc/documents/Operating%20Practices.pdf. Accessed September 2012.

British Columbia Ministry of Forests. 1997. *Silviculture Prescriptions Field Methods Book*. Interim Draft. Victoria, BC. Available online at: https://www.for.gov.bc.ca/hfd/pubs/docs/sil/Sil411/Sil411.htm. Accessed: April 2015.

Brown, G.S., W.J. Rettie, R.J. Brooks and F.F. Mallory. 2007. Predicting the impacts of forest management on woodland caribou habitat suitability in black spruce boreal forest. *Forest Ecology and Management* 245: 137–147.

Brown, W.K., J. Huot, P. Lamothe, S.N. Luttich, M. Pare, G. St. Martin and J.B. Theberge. 1986. The distribution and movement patterns of four woodland caribou herds in Quebec and Labrador. *Rangifer Special Issue* 1: 43–49.

Camill, P. 1999. Patterns of boreal permafrost peatland vegetation across environmental gradients sensitive to climate warming. *Canadian Journal of Botany* 77: 721–33.

Canada's Oil Sands Innovation Alliance. 2012. *COSIA*. Website: http://www.cosia.ca/. Accessed: March 2015.

Canadian Standards Association. 2011. *Z662-11 Oil and Gas Pipeline Systems*. Reprinted January 2012. 555 pp.

Caribou Range Restoration Project. 2007a. *Permanent Sample Plot Manual for the Caribou Range Restoration Project in Alberta, March 23, 2007*. Draft Unpublished Document.

Caribou Range Restoration Project. 2007b. *Caribou Range Restoration Project: Guidelines for Planning and Implementation*. Unpublished document created for the West–Central Alberta Petroleum Producers Group, Canadian Association of Petroleum Producers and Environment Canada. September 19, 2007.

Caribou Range Restoration Project. 2007c. *Little Smoky Caribou Habitat Restoration Pilot Project Summary*. Unpublished document prepared for Suncor Energy, ConocoPhillips Canada, Canadian Forest Products and Alberta Newsprint Co.

CH2M HILL Energy Canada, Ltd. 2014. *Environmental and Socio-Economic Assessment for the Proposed NOVA Gas Transmission Ltd. Liege Lateral Loop 2 – Thornbury Section Pipeline and the Leismer East Compressor Station Project*. Prepared for NOVA Gas Transmission Ltd. September 2014.

Cibrowski, J.J.H., A. Grgicak-Mannion, M. Kang, R. Rooney, Z. Hongcheng, K. Kovalenko, S.E. Bayley and A.L. Foote. 2012. *Development of a Regional Monitoring Program to Assess the Effects of Oil Sands Development on Wetland Communities Final Report*. Submitted to the Cumulative Environmental Management Association (CEMA). CEMA Contract. 2010-0029.

Collins, W.B. and T.S. Smith. 1991. Effects of wind-hardened snow on foraging by reindeer (*Rangifer tarandus*). *Arctic* 44(3): 217–222.

Committee on the Status of Endangered Wildlife in Canada. 2002. *COSEWIC Assessment and Update Status Report on the Woodland Caribou* Rangifer tarandus *Caribou in Canada*. Ottawa, ON. xi + 98 pp.

Committee on the Status of Endangered Wildlife in Canada. 2011. *Designatable Units for Caribou (*Rangifer tarandus*) in Canada*. Ottawa, ON. 88 pp.

Committee on the Status of Endangered Wildlife in Canada. 2015. *Canadian Species at Risk*. Website: http://www.cosewic.gc.ca/eng/sct5/index_e.cfm. Accessed: April 2015.

Courtin, P.J. and K.R. Brown. 2001. *The Use of Red Alder to Enhance Sitka Spruce Growth in the Queen Charlotte Islands*. Forest Research Extension Note EN-008. BC Ministry of Forests, Vancouver Forest Region. Nanaimo, BC. 4 pp.

Courtois, R. and J.P. Ouellet. 2007. Modelling the impact of moose and wolf management on persistence of woodland caribou. *Alces* 43: 13–27.

DeCesare, N.J., M. Hebblewhite, F. Schmiegelow, D. Hervieux, G.J. McDermid, L. Neufeld, M. Bradley, J. Whittington, K.G. Smith, L.E., Morgantini, M. Wheatley and M. Musiani. 2012. Transcending scale dependence in identifying habitat with resource selection functions. *Ecological Applications* 22(4): 1068–1083.

Diversified Environmental Services. 2004. *Canadian Natural Resources Ltd. Ladyfern Pipeline d-87-H/94-H-1, British Columbia to NE Section 20- Township 94-Range 12 W6M, Alberta: Revegetation Monitoring Report Year 2 (2003)*. Prepared for: Canadian Natural Resources Ltd. 18 pp. + Appendices.

Dyer, S.J. 1999. *Movement and Distribution of Woodland Caribou (*Rangifer tarandus caribou*) in Response to Industrial Development in Northeastern Alberta*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. *Journal of Wildlife Management* 65(3): 531–542.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2002. Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta. *Canadian Journal of Zoology* 80(5): 839–845.

Edmonds, E.J and M. Bloomfield. 1984. *A Study of Woodland Caribou (*Rangifer tarandus caribou*) in West-Central Alberta, 1979 to 1983*. Alberta Energy and Natural Resources, Fish and Wildlife Division. Edmonton, AB.

Ehlers, L.P.W., C.J. Johnson and D.R. Seip. 2014. Movement ecology of wolves across an industrial landscape supporting threatened populations of woodland caribou. *Landscape Ecology* 29(3): 451–465.

Enbridge Pipelines (Athabasca) Inc. 2010. *Waupisoo Pipeline Project: 2010 Green Area Post-Construction Reclamation Assessment*. Submitted to Alberta Sustainable Resource Development.

Environment Canada. 2011. *Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada: 2011 Update*. Ottawa, ON. 103 pp.

Environment Canada. 2012. *Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada*. *Species at Risk Act* Recovery Strategy Series. Ottawa, ON. xi + 138 pp.

Environment Canada. 2015. *Species at Risk Public Registry*. Website: http://www.sararegistry.gc.ca/species/default_e.cfm. Accessed: April 2015.

Esri User Conference. 1996. *1996 User Conference Proceedings*. Esri User Conference. Website: http://proceedings.esri.com/library/userconf/proc96/WELCOME.HTM. Accessed: April 2015.

Frankham, R. 2005. Genetics and extinction. *Biological Conservation* 126(2): 131–140.

Girard, M., C. Lavoie and M. Thériault. 2002. The regeneration of a highly disturbed ecosystem: A mined peatland in southern Québec. *Ecosystems* 5: 274–288.

Golder Associates Ltd. 2005. *Firebag Project 2004 Seismic Line Reclamation Study Annual Report*. Submitted to: Suncor Firebag Inc.

Golder Associates Ltd. 2007. *Audit of Operating Practices and Mitigation Measures Employed Within Woodland Caribou Ranges*. Submitted to Caribou Landscape Management Association. Peace River, AB.

Golder Associates Ltd. 2009. *Caribou Habitat Restoration Pilot Study*. Prepared for Conoco Phillips Canada, Suncor Energy and Canadian Association of Petroleum Producers. 41 pp.

Golder Associates Ltd. 2010. *Canadian Natural Resources Limited: Primrose and Wolf Lake: Wildlife Habitat Enhancement Program Development and Implementation*. Submitted to: Canadian Natural Resources Ltd. Calgary, AB.

Golder Associates Ltd. 2011. *Waupisoo Pipeline 2011 Seedling Monitoring Plot Summary*. Submitted to Enbridge Pipelines (Athabasca) Inc.

Golder Associates Ltd. 2012a. *Boreal Caribou Habitat Restoration*. Prepared for: Ministry of Forests, Lands and Natural Resource Operations. Fish Wildlife and Habitat Management Branch, Government of British Columbia. Prince George, BC. 24 pp.

Golder Associates Ltd. 2012b. *Interconnect Pipeline 2011 Seedling Monitoring Plot Summary*. Memo submitted to CNRL February 23, 2012.

Golder Associates Ltd. 2014. *Final Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Leismer to Kettle River Crossover Project*. Prepared for NOVA Gas Transmission Ltd.

Golder Associates Ltd. 2015. *Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia*. Prepared for BC Science and Community Environmental Knowledge (SCEK) Fund's Research and Effectiveness Monitoring Board (REMB). Calgary, AB.

Government of Alberta. 2011. *A Woodland Caribou Policy for Alberta*. 2 pp.

Hawkes, V.C. 2011. *Early Successional Wildlife Monitoring On Reclamation Plots in the Athabasca Oil Sands Region*. British Columbia Mine Reclamation Symposium. British Columbia Technical and Research Committee on Reclamation, Vancouver, BC.

Hedrick, P.W. and S.T. Kalinowski. 2000. Inbreeding depression in conservation biology. *Annual Review of Ecology and Systematics* 31: 139–162.

Hervieux, D., M. Hebblewhite, N.J. DeCesare, M. Russell, K. Smith, S. Robertson and S. Boutin. 2013. Widespread declines in woodland caribou (*Rangifer tarandus caribou*) continue in Alberta. *Canadian Journal of Zoology* 91(12): 872–882.

Hunt, L.M. and M. Hupf. 2014. The effectiveness of road closures and deactivations at reducing traffic: A case of resource roads used for recreational activities in Ontario, Canada. *The Forestry Chronicle* 90(5): 670–677.

James, A.R.C. 1999. *Effects of Industrial Development On the Predator–Prey Relationship Between Wolves and Caribou in Northeastern Alberta*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

James, A.R.C. and A.K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. *Journal of Wildlife Management* 64: 154–159.

James, A.R.C., S. Boutin, D.M. Hebert and A.B. Rippin. 2004. Spatial separation of caribou from moose and its relation to predation by wolves. *Journal of Wildlife Management* 68: 799–809.

Keller, L.F. and D.M. Waller. 2002. Inbreeding effects in wild populations. *Trends in Ecology and Evolution* 17(5): 230–241.

Khasa, P.D., L. Sigler, P. Chakravarty, B.P. Dancik, L. Erikson and D. Mc Curdy. 2001. Effect of fertilization on growth and ectomycorrhizal development of container-grown and bare-root nursery conifer seedlings. *New Forestry* 22: 179–197.

LaPerriere, A.J. and P.C. Lent. 1977. Caribou feeding sites in relation to snow characteristics in northeastern Alaska. *Arctic* 30: 101–108.

Latham, A.D.M. 2009. *Wolf Ecology and Caribou-Primary Prey-Wolf Spatial Relationships in Low-Productivity Peatland Complexes in Northeastern Alberta*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

Latham, A.D.M., M.C. Latham, N.A. McCutchen and S. Boutin. 2011. Invading white-tailed deer change wolf–caribou dynamics in northeastern Alberta. *The Journal of Wildlife Management* 75(1): 204-212.

Lee, P. and S. Boutin. 2006. Persistence and developmental transition of wide seismic lines in the western Boreal Plains of Canada. *Journal of Environmental Management*. 78: 240–250.

Macadam, A. and L. Bedford. 1998. Mounding in the Sub-Boreal Spruce Zone of west-central British Columbia: 8-year results. *The Forestry Chronicle* 74(3): 421–427.

MacDonald, E., S. Quideau and S. Landhäusser. 2012. Rebuilding boreal forest ecosystems after industrial disturbance. Pp 123-159 in *Restoration and Reclamation of Boreal Ecosystems*. D.H. Vitt and J.S. Bhatti, (Eds.). Cambridge University Press, Cambridge, UK.

MacFarlane, A.K. 1999. *Revegetation of Wellsites and Seismic Lines in the Boreal Forest*. B.Sc. Honour's Thesis, University of Alberta. Edmonton, AB.

MacFarlane, A.K. 2003. *Vegetation Response to Seismic Lines: Edge Effects and Online Succession*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

MacIsaac, D.A., G.R. Hillman and P.A. Hurdle. 2004. *Alternative Silvicultural Systems for Harvesting and Regenerating Spruce-Dominated Boreal Mineral Wetlands*. Canadian Forest Service, Northern Forestry Centre. Information Report Nor-X-399.

McCutchen, N.A. 2007. *Factors Affecting Caribou Survival in Northern Alberta: The Role of Wolves, Moose and Linear Features*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

McKay, T., K. Graham and G. Stenhouse. 2014. *Grizzly Bears and Pipelines: Response to Unique Linear Features*. Year 2 (2013) Final Report. Alberta Upstream Petroleum Research Fund (13-AU-ERPC-03). Foothills Research Institute Grizzly Bear Program. Hinton, AB.

McKenzie, H.W., E.H. Merrill, R.J. Spiteri and M.A. Lewis. 2012. How linear features alter predator movement and the functional response. *Interface Focus* 2(2): 205–216.

McLoughlin, P.D., E. Dzus, B. Wynes and S. Boutin. 2003. Declines in populations of woodland caribou. *The Journal of Wildlife Management* 67(4): 755–761.

McNay, R.S., G. Sutherland, L. Giguere, J. Gollner, K. Sittler, F. MacDonald and V. Brumovsky. 2014. *Multi-Scale Responses by Predators and Prey to Deactivation/Restoration of Disturbance Features – Individual and Population Components*. Interim Report 2013-2014. Wildlife Infometrics Report 470, Wildlife Infometrics Inc. Mackenzie, BC.

Naeth, M.A., D.J. White, D.S. Chanasyk, T.M. Macyk, C.B. Powter and D.J. Thacker. 1991. *Soil Physical Properties in Reclamation*. Alberta Land Conservation and Reclamation Council Report No. RRTAC 91-4. Edmonton, AB.

Neufeld, L.M. 2006. *Spatial Dynamics of Wolves and Woodland Caribou in an Industrial Forest Landscape in West–Central Alberta*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

North American Caribou Workshop. 2014. *Caribou Conservation and Management: What's Working?* Website: http://www.2014nacw.ca/Portals/10/NACWprogramfinal_web.pdf. Accessed: April 2015.

NOVA Gas Transmission Ltd. 2014a. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 1*. Hearing Order N081-2014. November 14, 2014.

NOVA Gas Transmission Ltd. 2014b. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 2*. Hearing Order N081-2014. December 19, 2014.

NOVA Gas Transmission Ltd. 2015. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 3.* Hearing Order N081-2014. January 7, 2015.

O'Brien, D., M. Manseau and A. Fall. 2006. Testing the importance of spatial configuration of winter habitat for woodland caribou: An application of graph theory. *Biological Conservation* 130: 70–83.

Oberg, P.R. 2001. *Responses of Mountain Caribou to Linear Features in a West–Central Alberta Landscape*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

Ohlson, D. 2014. *SM 800 – Linear Footprint and Access Management*. CEMA Linear Footprint Task Group Stony Mountain 800 Multi-Stakeholder Planning Pilot. Cumulative Environmental Management Association. Fort McMurray, AB. 209 pp.

Osko, T. and M. Glasgow. 2010. *Removing the Wellsite Footprint: Recommended Practices for Construction and Reclamation of Wellsites on Upland Forests in Boreal Alberta*. University of Alberta, Department of Biological Sciences. Edmonton, AB. 61 pp.

Osko, T. J. and A. K. MacFarlane. 2000. *Natural Reforestation Rates on Seismic Lines and Wellsites in Comparison to Natural Burns Or Logged Sites*. Alberta–Pacific Forest Industries. Boyle, AB.

Peters, W., M. Hebblewhite, N. DeCesare, F. Cagnacci and M. Musiani. 2013. Resource separation analysis with moose indicates threats to caribou in human altered landscapes. *Ecography* 34(4): 487–498.

Polster, D.F. 2002. Soil bioengineering techniques for riparian restoration. In *Proceedings of the 26th Annual British Columbia Mine Reclamation Symposium*. Dawson Creek, BC. 230–239.

Pyper, M. and T. Vinge, 2012. *A Visual Guide to Handling Woody Materials for Forested Land Reclamation.* Report No. TR-31. University of Alberta, School of Energy and the Environment, Oil Sands Research and Information Network. Edmonton, AB. 10 pp.

Rettie, W.J. and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Canadian Journal of Zoology* 76: 251–259.

Rettie, W.J. and F. Messier. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. *Ecograph*y 23: 466–478.

Revel, R. D., T. D. Dougherty and D. J. Downing. 1984. *Forest Growth and Revegetation Along Seismic Lines*. University of Calgary Press. Calgary, AB.

Ripple, W. J. and R. L. Beschta. 2004. Wolves and the ecology of fear: Can predation risk structure ecosystems? *BioScience* 54(8): 755–766.

Ripple, W. J., J. A. Estes, R. L. Beschta, C. C. Wilmers, E. G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M. P. Nelson, O. J. Schmitz, D. W. Smith, A. D. Wallach and A. J. Wirsing. 2014. Status and ecological effects of the world's largest carnivores. *Science* 343(6167): 1241484.

Robinson, S.D. and Moore, T.R. 2000. The influence of permafrost and fire upon carbon accumulation in high boreal peatlands, Northwest Territories, Canada. *Arctic, Antarctic and Alpine Research* 32: 155–166.

Rohner, C. and G. Kuzyk. 2000. *Wolves and Caribou in West–Central Alberta: Predator Responses to Industrial Resource Development*. Research News 3, University of Alberta and West–Central Caribou Standing Committee. Edmonton, AB. 4 pp.

Roy, V., P.-Y. Bernier, A.P. Plamondon and J.-C. Ruel. 1999. Effect of drainage and microtopography in forested wetlands on the microenvironment and growth of planted black spruce seedlings. *Canadian Journal of Forest Research* 29: 563–574.

Sanborn, P., R. Brockley and C. Preston. 2001. *Effects of Sitka Alder Retention and Removal on the Growth of Young Lodgepole Pine in the Central Interior of British Columbia (EP 1185): Establishment Report*. Working Paper 60/2001. BC Ministry of Forests, Research Branch. Victoria, BC. 44 pp.

Schaefer, J.A. and W.O. Pruitt. 1991. Fire and woodland caribou in southeastern Manitoba. *Wildlife Monographs* 116: 1–39.

Seip, D.R. and D.B. Cichowski. 1996. Population ecology of caribou in British Columbia. *Rangifer* 9: 73-80.

Serrouya, R., D. Paetkau, B.N. McLellan, S. Boutin, M. Campbell and D.A. Jenkins. 2012. Population size and major valleys explain microsatellite variation better than taxonomic units for caribou in western Canada. *Molecular Ecology* 21(11): 2588–2601.

Sherrington, P.M. 2003. *Measuring Boreal Forest Fragmentation Change in Response to Seismic Line, Wellsite and Road Revegetation With Scanned False-Colour Infrared Aerial Photography*. MGIS Thesis, University of Calgary. Calgary, AB.

Simard, S. and J. Heineman. 1996. *Nine-Year Response of Lodgepole Pine and the Dry Alder Complex to Chemical and Manual Release Treatments on an ICHmk1 Site Near Kelowna*. FRDA Report 259. BC Ministry of Forests. Kamloops, BC. 19 pp.

Stantec Consulting Limited. 2014. *Final Caribou Habitat Restoration Plan for the Chinchaga Lateral Loop No. 3 (Chinchaga Section)*. Prepared for NOVA Gas Transmission Ltd. Calgary, AB.

Stokes, D., S. Duncan and J.R. Turner. 2009. *An Adaptive Approach to Reclaiming the First Coal Corporation Central South Property*. British Columbia Mine Reclamation Symposium 2009.

Straker, J. and G. Donald. 2011. *Assessing Re-Establishment of Functional Forest Ecosystems on Reclaimed Oil Sands Mine Lands*. British Columbia Mine Reclamation Symposium. British Columbia Technical and Research Committee on Reclamation, Vancouver, BC.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. *The Journal of Wildlife Management* 61: 622–633.

Sweeney, S. 2005. Alder: The nitrogen fix: Ontario trees and shrubs. *The Monday Garden* 151. February 13, 2005.

Switalski, T.A. and C.R. Nelson. 2011. Efficacy of road removal for restoring wildlife habitat: Black bear in the northern Rocky Mountains, USA. *Biological Conservation* 144(2011): 2666–2673.

Tedder, W.S. and L.W. Turchenek. 1996. Natural revegetation of an Alberta peatland after horticultural peat extraction. In *4th Annual Canadian Peatland Restoration Workshop, 13–14 July, Quebec City, Canada*. Universite Laval, Faculte des Sciences de Sciences de L'agriculture et de .l'alimentation. Quebec City, QC.

TERA Environmental Consultants. 2011a. *Caribou Habitat Restoration Plan for the Proposed NOVA Gas Transmission Ltd. Horn River Mainline Project, Part II*. Updated September 2011. Prepared for NOVA Gas Transmission Ltd.

TERA Environmental Consultants. 2011b. *Post-Construction Monitoring Report for the Trans Mountain Pipeline L.P. TMX – Anchor Loop Project*. Prepared for Trans Mountain Pipeline L.P. December 2011. 78 pp. + Appendices.

TERA Environmental Consultants. 2012. *Supplemental Update for the Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Horn River Mainline Project, Part II*.

TERA Environmental Consultants. 2014a. *Final Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Northwest Mainline Expansion*. Prepared for NOVA Gas Transmission Ltd.

TERA Environmental Consultants. 2014b. *Traditional Knowledge Report (NEB Filing ID A4C2V4) for the Proposed NOVA Gas Transmission Ltd. Liege Lateral Loop 2 (Thornbury Section) Project* Prepared for NOVA Gas Transmission Ltd.

Thomas, D.C. and D.R. Gray. 2002. Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada. In *COSEWIC Assessment and Update Status Report on the Woodland Caribou* Rangifer tarandus caribou *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 98 pp.

Thurber, J.M., R.O. Peterson, T.D. Drummer and S.A. Thomasma. 1994. Gray wolf response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin* 22: 61–68.

Turetsky, M.R., R.K. Wieder, C.J. Williams and D.H. Vitt. 2000. Organic matter accumulation, peat chemistry, and permafrost melting in peatlands of boreal Alberta. *Écoscience* 7: 379–392.

Vinge, T. (unpublished). *Treatment Matrix for Linear Restoration*. 2014.

Vinge, T. and M. Pyper. 2012. *Managing Woody Materials on Industrial Sites: Meeting Economic, Ecological and Forest Health Goals Through a Collaborative Approach*. University of Alberta, Department of Renewable Resources. Edmonton, AB. 32 pp.

Vistnes, I. and C. Nellemann. 2001. Avoidance of cabins, roads and power lines by reindeer during calving. *Journal of Wildlife Management* 65: 915–925.

Westland Resource Group. 2011. *TMX Anchor Loop Project: Wildlife and Wildlife Habitat Post Construction Monitoring Year 2 Report*. Prepared for Kinder Morgan Canada c/o TERA Environmental Consultants.

Whittington, J., M. Hebblewhite, N.J. DeCesare, L. Neufeld, M. Bradley, J. Wilmshurst and M. Musiani. 2011. Caribou encounters with wolves increase near roads and trails: A time-to-event approach. *Journal of Applied Ecology* 48: 1535–1542.

Wittmer, H.U., A.R.E. Sinclair and B.N. McLellan. 2005. The role of predation in the decline and extirpation of woodland caribou. *Oecologia* 144: 257–267.

Zager, P. and J. Beecham. 2006. The role of American black bears and brown bears as predators on ungulates in North America. *Ursus* 17(2): 95–108.

9.2 GIS DATA AND MAPPING REFERENCES

This subsection includes references cited in the figures accompanying this report.

AESRD. 2014. *Alberta Wildfire Perimeters: 1931 to 2013(digital file)*. Edmonton, AB. Available: http://esrd.alberta.ca/wildfire/wildfire-maps/historical-wildfire-information/spatial-wildfire-data.aspx. Acquired: April 30, 2014. Update Interval: Annually.

Alberta Environment and Sustainable Resource Development. 2013. *Caribou Range* (digital file). Edmonton, AB. Available: http://esrd.alberta.ca/forms-maps-services/maps/wildlife-sensitivity-maps/default.aspx. Acquired: April 2013. Last Update Check: February 20, 2015.

Alberta Environment and Sustainable Resource Development. 2014. *Key Wildlife and Biodiversity Zone* (digital file). Edmonton, AB. Available: http://esrd.alberta.ca/forms-maps-services/maps/wildlife-sensitivity-maps/default.aspx. Acquired: March 2014. Last Update Check: February 20, 2015.

Alberta Tourism, Parks and Recreation. 2012. *Protected Areas* (pashape_ocsites_10tm) (digital file). Edmonton, AB. Available: http://albertaparks.ca/albertaparksca/library/downloadable-data-sets.aspx. Acquired: February 2013. Last Update Check: November 7, 2014.

AltaLIS. 2009. *Alberta Township System Version 4.1* (digital file). Calgary, AB. Available: http://www.altalis.com. Acquired: October 2009. Last Update Check: June 5, 2014.

BlackBridge Geomatics. 2015. *SPOT6 1.5 m Colour Satellite Imagery* (digital file). Lethbridge, AB. Available: www.blackbridge.com. Acquired: December, 2014.

Government of Canada. 2014. *Aboriginal Lands, Canada* (digital file). Edmonton, AB. Available: http://www.geobase.ca. Acquired: January 2015. Last Update Check: January 15, 2015.

IHS Inc. 2014. *IHS Facility Data* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. *IHS Enhanced Pipeline Data* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. *IHS Road Segments* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. IHS Wells - Surface Hole (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

Natural Resources Canada. 2003. *Canadian Geographical Names* (digital file). Ottawa, ON. Available: http://geobase.ca/geobase/en/data/cgn/index.html. Acquired: June 2014. Last Update Check: January 6, 2015.

Natural Resources Canada. 2007-2011. *National Hydro Network* (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/nhn/index.html. Acquired: April 2012. Last Update Check: May 2012.

Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. 2009. *Land Cover, Circa 2000 – Vector* (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/landcover/index.html. Acquired: September 2009. Last Update Check: November 2011.

Natural Resources Canada. 2014. *National Road Network – Alberta* (digital file). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/nrn/index.html. Acquired: September 2014. Last Update Check: January 2, 2015.

TERA, a CH2M HILL Company. 2008. *Hillshade*. Derived from Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. 2000–2008. Canadian Digital Elevation Data 250k (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/cded/index.html. Acquired: 2008. Last Update Check: December 2010.

TransCanada 2014. *Leismer East Compressor Station* (digital files). Calgary, AB. Acquired: June 2014. Last Update Check: June 2, 2014.

TransCanada 2014. *Liege Lateral Loop 2 – Thornbury Section Pipeline, KPs* (digital files). Calgary, AB. Acquired: November 2014. Last Update Check: November 18, 2014.

TransCanada. 2014. *Access Road, Government Road Allowance* (digital files). Calgary, AB. Received: October 31, 2014.

TransCanada. 2014. *Contingency Crossing Location* (digital file). Calgary, AB. Received May 9, 2014.

TransCanada. 2014. *Existing Compressor Station* (digital files). Calgary, AB. Received: June 23, 2014.

Appendix A

Appendix A includes photoplates that illustrate many of the typical restoration methods and constraints discussed in this CHRP, as well as examples of site conditions that present opportunities or limitations to implementation of restoration measures.

Plate 1 Example of coarse woody debris rollback, used to enhance revegetation. The coverage in this photo is insufficient for access management. Photo source: Pyper and Vinge 2012.

Plate 2 Example of coarse woody debris rollback for access management on a pipeline right-of-way. The debris also creates microsites to enhance vegetation establishment and growth. The trench material has not yet settled in this photo. Photo source: NGTL.

Plate 3 Example of conifer seedling planting on a pipeline right-of-way. The upland area has sufficient drainage and suitable soils for seedling establishment and growth. Photo source: CH2M HILL.

Plate 4 Example of mounding used as an access management measure and to facilitate caribou habitat restoration through the creation of microsites that improve vegetation establishment. The treated linear disturbance is a seismic line, which is substantially narrower than a pipeline right-of-way. Photo source: Golder 2013, in TERA 2014a.

Plate 5 Example of mounding a seismic line. Photo source: Golder 2013, in TERA 2014a.

Plate 6 Example of mounding combined with tree-felling and conifer seedling planting on a seismic line. The combination of measures (often referred to as “line-blocking”) is intended to manage human and predator access, and facilitate revegetation of conifers. Photo source: Golder 2013, in TERA 2014a.

Plate 7 Example of excavator mounding with tree planting. Mounds create microsites that can enhance survival and growth of planted seed and seedlings, and natural regrowth of woody species. It is commonly used in wet, low-lying areas to create better drained microsites for seedlings. Photo source: Golder 2013, in TERA 2014a.

Plate 8 Example of a vegetation screen retained along edge of pipeline right-of-way at intersection with an existing linear disturbance. Vegetation screens block line-of-sight and can effectively manage access. Photo source: CH2M HILL.

Plate 9 Example of a wood berm to deter access and reduce line-of-sight. To effectively block line-of-sight, berms should be constructed to an approximate minimum height of 1.5-2 m. Alternate measures are preferred over berms given the multiple limitations and low value. Value may be improved with shrub planting at base of berm and extending into adjacent forest. Photo source: NGTL.

Plate 10 Example of a ramp-over area where a snow ramp was packed over vegetation. The resultant vegetation screen will contribute to natural regeneration on the adjacent areas of the footprint and partially break the line-of-sight. Site conditions and construction requirements can limit the use of this measure. Photo source: CH2M HILL.

Plate 11 Example of a ramp-over area. This method can be an effective option in treed lowlands where alternate measures such as mounding and conifer seedling planting can be logistically difficult to implement successfully. Photo source: CH2M HILL.

Plate 12 Example of natural regeneration during the first growing season following pipeline construction in an upland/transitional site where minimum disturbance construction was implemented. Natural regeneration of alder, willow, rose, and various forbs is evident. Natural regeneration was supplemented with white spruce seedling planting in this location. Photo source: CH2M HILL.

Plate 13 Example of a log berm combined with woody debris rollback for access management and line-of-sight break. The woody debris is placed along the pipeline right-of-way, set back from the wider road crossing area (extra temporary workspace was needed to install the pipeline across the road). By setting back the debris rollback and berm, a larger area of coverage could be achieved than would be possible immediately adjacent to the road. Photo source: CH2M HILL.

Plate 14 Example of a combination of access management measures: rollback (upland/transitional area) and mounding (lowland area). The volume of woody debris at this location was increased to comply with regulatory request. The coverage in this location, while effective for access management, is excessive for facilitating vegetation establishment. Photo source: NGTL.

Plate 15 Example of a treed fen with standing water. In very wet habitat types minimum disturbance construction during frozen conditions and measures such as ramp-overs allow for natural revegetation. Rollback, mounding and seedling planting are not effective in wet treed fens due to the lack of drainage and soil cohesion (saturated peat does not retain mounds, support debris, or allow for tree growth). Photo source: CH2M HILL.

Plate 16 Example of an existing linear disturbance in an upland deciduous forest type in northeast Alberta, dominated by aspen and Alaska birch interspersed with white spruce. Minimum disturbance construction in habitats such as this facilitates rapid regeneration of native deciduous species. Vegetation competition may limit the effectiveness of conifer seedling planting. Photo source: CH2M HILL.

Plate 17 Example of a mixedwood forest, dominated by trembling aspen, balsam poplar and white spruce. Minimum disturbance construction can facilitate rapid regeneration of mixedwood sites, due to the deciduous component. Conifer seedling planting can be an effective revegetation measure, but may be limited by competition among vegetation. Photo source: CH2M HILL.

Plate 18 Example of a regenerating seismic line in an upland/transitional coniferous forest. Transitional habitat types may be suitable for mounding and conifer seedling planting. Coarse woody debris can enhance restoration as well as manage access. Photo source: CH2M HILL.

Plate 19 Example of natural terrain variation that contributes to reducing line-of-sight in combination with a bend in the existing linear feature. Photo source: CH2M HILL.

Plate 20 Example of multiple rights-of-way in a treed fen. Regrowth of vegetation can be limited by soil temperature, drainage and nutrients. Line-of-sight breaks and access management measures are ineffective in locations such as this. Minimum disturbance construction during frozen conditions (including ramp overs) are typically the preferred option for enhancing restoration. Photo source: CH2M HILL.

Plate 21 Example of an existing seismic line where natural regeneration and fallen trees are deterring motorized access. Intersections of pipeline rights-of-way with regenerating seismic lines such as these typically do not warrant access management. Photo source: CH2M HILL.

Plate 22 Example of an electrical transmission line paralleling an existing pipeline right-of-way. Where a new pipeline right-of-way parallels an existing linear corridor with multiple rights-of-way, access management would not be effective. Photo source: CH2M HILL.

Plate 23 Example of multiple existing linear disturbances that facilitate access (plowed roads, pipeline right-of-way). Access management on a new paralleling pipeline right-of-way would be ineffective. Photo source: CH2M HILL.

Plate 24 Example of access management (wood berm) on a new paralleling pipeline right-of-way that would be ineffective due to existing linear disturbances that facilitate access. Photo source: CH2M HILL.

Plate 25 Example of access/line-of-sight management (earth berm) on a new pipeline right-of-way. The measure is unlikely to be effective due to its location relative to existing roads and pipeline right-of-way. Photo source: CH2M HILL.

Plate 26 Example of multiple existing linear disturbances that facilitate access (roads, pipeline right-of-way). Access management (earth berm) on the new paralleling pipeline right-of-way is unlike to be effective. Photo source: CH2M HILL.

Appendix B

Preliminary CHRP Treatment Matrix and Key Considerations Summary for Liege Lateral Loop 2 (Thornbury Section) Project

Project-Specific Information[1]								Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region (AENV 2010)[5]				AESRD Treatment Matrix for Linear Restoration (Vinge pers. comm. 2014)[5]		NGTL Caribou Habitat Restoration – Implementation Lessons from Previous Projects	Preliminary CHRP Potential Restoration Treatment Options
Habitat Types	Land Cover Classification	AVICode[2,3]	Site Type[4]	Limiting Factors	Area (ha)	Percent of Total (%)	Typical Overstory Species	Planting Density (stems/ha) Min	Planting Density (stems/ha) Max	Target Density (8 years after planting) (stems/ha) Min	Target Density (8 years after planting) (stems/ha) Max	Treatment Recommendations	Treatment Targets		
Treed Wetland (Lowland)	Wetland – treed (81)	--	Wet Poor (treed fen)	Soil temperature, drainage and nutrients	23.5	26.5	Sb, Lt	700 (Sb) where crown closure is ≤ 50% 1,400 (Sb) where crown closure is > 50%	1,400 (Sb) where crown closure is ≤ 50% 2,800 (Sb) where crown closure is > 50%	630 (Sb) where crown closure is ≤ 50% 1,260 (Sb) where crown closure is > 50%	1,260 (Sb) where crown closure is ≤ 50% 2,520 (Sb) where crown closure is > 50%	CWD: 10-50 m^3/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (Sb) Final minimal stem density: 1,000 stems/ha Stock size: medium Treatment: plant or natural seed	Target spp: Sb Coverage: 25% woody or herbaceous Number of spp.: 3	Minimum disturbance and natural regeneration Mounding for access management/microsites • Target mound density: 400-1,400 mounds/ha • Typical mound density achieved: 700-1,400 mounds/ha CWD rollback for access management • Typical coverage: 250-300 m^3/ha; spread over 50-100 m length spanning width of footprint Conifer seedling planting: • Target planting density on mounded sites: 2,000-2,500 stems/ha • Target planting density on unmounded sites: 400-1,000 stems/ha • Typical planting densities achieved: TBD with monitoring	Construction measures that facilitate restoration (*e.g.*, minimum disturbance where construction requirements and site conditions allow; retain vegetation screens; etc.) Natural regeneration CWD for access management • Target CWD coverage: 200-300 m^3/ha spread over minimum length of 50 m (target 70-100 m) for full footprint width Mounding for access management/microsites in transitional habitats • Target mound density: 700-1,400 mounds/ha Conifer seedling planting (species to be determined based on adjacent site characteristics and post-construction site conditions on the footprint • Target planting density (mounded): 1,400-2,500 stems/ha (depending on mound density) • Target planting density (unmounded): 2,000-2,500 stems/ha (if appropriate, depending on site drainage and nutrients) Bio-engineering/shrub staking at riparian areas with erosion risk
Shrubby/Herbaceous Wetland (Lowland)	Wetland – shrub (82)	--	Wet Poor (treed fen)	Soil temperature, drainage and nutrients	14.4	16.3	Sb, Lt	700 (Sb) where crown closure is ≤ 50% 1,400 (Sb) where crown closure is > 50%	1,400 (Sb) where crown closure is ≤ 50% 2,800 (Sb) where crown closure is > 50%	630 (Sb) where crown closure is ≤ 50% 1,260 (Sb) where crown closure is > 50%	1,260 (Sb) where crown closure is ≤ 50% 2,520 (Sb) where crown closure is > 50%	CWD: 10-50 m^3/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (Sb) Final minimal stem density: 1,000 stems/ha Stock size: medium Treatment: plant or natural seed	Target spp: Sb Coverage: 25% woody or herbaceous Number of spp.: 3	Minimum disturbance and natural regeneration Bio-engineering/shrub staking in shrubby riparian areas where there is a risk of erosion	Construction measures that facilitate restoration (*e.g.*, minimum disturbance where construction requirements and site conditions allow; retain vegetation screens; etc.) Natural regeneration Shrub staking (species and density to be determined based on adjacent site characteristics and post-construction site conditions on the footprint)
	Wetland – herb (83)	--	Wet Rich/Wet Poor (treed fen, emergent marsh)	Soil temperature, drainage and nutrients	17.2	19.4	Sb, Lt	600 (250 Sw and 350 Sb) where crown closure is ≤ 50% and site is Wet Rich 700 (Sb) where crown closure is ≤ 50% and site is Wet Poor	1,400 (600 Sw and 800 Sb) where crown closure is ≤ 50% and site is Wet Rich 1,400 (Sb) where crown closure is ≤ 50% and site is Wet Poor	540 (225 Sw and 315 Sb) where crown closure is ≤ 50% and site is Wet Rich 630 (Sb) where crown closure is ≤ 50% and site is Wet Poor	1,260 (540 Sw and 720 Sb) where crown closure is ≤ 50% and site is Wet Rich 1,260 (Sb) where crown closure is ≤ 50% and site is Wet Poor	CWD: 10-50 m^3/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (Sb) Final minimal stem density: 1,000 stems/ha Stock size: medium Treatment: plant or natural seed	Target spp: Sb Coverage: 25% woody or herbaceous Number of spp.: 3	Minimum disturbance and natural regeneration	Construction measures that facilitate restoration (*e.g.*, minimum disturbance where construction requirements and site conditions allow; retain vegetation screens; etc.) Natural regeneration Shrub staking (species and density to be determined based on adjacent site characteristics and post-construction site conditions on the footprint)

Project-Specific Information[1]								Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region (AENV 2010)[5]				AESRD Treatment Matrix for Linear Restoration (Vinge pers. comm. 2014)[5]		NGTL Caribou Habitat Restoration – Implementation Lessons from Previous Projects	Preliminary CHRP Potential Restoration Treatment Options
Habitat Types	Land Cover Classification	AVICode[2,3]	Site Type[4]	Limiting Factors	Area (ha)	Percent of Total	Typical Overstory	Planting Density (stems/ha)		Target Density (8 years after planting) (stems/ha)		Treatment Recommendations	Treatment Targets		
Coniferous Forest – Upland/Transitional	Coniferous Dense (211)	C17Pj7Sw3 C21Pj7Sw3 C21Pj4Sw4Aw2	Dry	Moisture and nutrients	19.4	21.9	Pj, Sw, Aw	1,400 (Pj or 800 Pj and 600 Sw)	2,000 (Pj or 1,200 Pj and 800 Sw)	1,260 (Pj or 720 Pj and 540 Sw)	1,800 (Pj or 1,080 Pj and 720 Sw)	CWD: 75-100 m^3/ha Site prep: light surface Mound density: none Planting density: none Final minimal stem density: 2,000 Stock size: none Treatment: natural or applied seed	Target spp: jack pine Coverage: 25% woody or herbaceous Number of spp.: 3	Minimum disturbance and natural regeneration Mounding for access management/microsites • Transitional areas between upland and lowland forests • Target mound density: 400-1,400 mounds/ha • Typical mound density achieved: 700-1,400 mounds/ha CWD rollback for access management • Typical coverage: 250-300 m^3/ha; spread over 50-100 m length spanning width of footprint Conifer seedling planting: • Target planting density on mounded sites: 2,000-2,500 stems/ha • Target planting density on unmounded sites: 800-1,400 stems/ha • Typical planting densities achieved: TBD with monitoring	Construction measures that facilitate restoration (*e.g.*, minimum disturbance where construction requirements and site conditions allow; retain vegetation screens; etc.) Natural regeneration CWD for access management • Target CWD coverage: 200-300 m^3/ha spread over minimum length of 50 m (target 70-100 m) for full footprint width Mounding for access management/microsites in transitional habitats • Target mound density: 700-1,400 mounds/ha Conifer seedling planting (species to be determined based on adjacent site characteristics and post-construction site conditions on the footprint • Target planting density (mounded): 1,400-2,500 stems/ha (depending on mound density) • Target planting density (unmounded): 2,000-2,500 stems/ha Bio-engineering/shrub staking at riparian areas with erosion risk
		C19Pj6Sb2Sw1Aw1	Moist Poor	Soil temperature and nutrients			Pj, Sb, Sw, Aw	1,400 (1,000 Pj and 400 Sb)	2,000 (1,500 Pj and 500 Sb)	1,260 (900 Pj and 360 Sb)	1,800 (1,350 Pj and 450 Sb)	CWD: 75-100 m^3/ha Mound density: 1,200/ha Planting density: 800 stems/ha (jack pine) 400 stems/ha (Sb) Final minimal stem density: 1,000 Stock size: small Treatment: plant or natural seed	Target spp: jack pine or Sb Coverage: 25% woody or herbaceous Number of spp.: 5		
	Coniferous Open (212)	B15Sw7Pj3	Moist Rich	Soil temperature and competition	8.1	9.1	Sw, Pj	500 (Sw)	1,400 (Sw)	400 (Sw)	1,260 (Sw)	CWD: 75 m^3/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (white spruce) Final minimal stem density: 1,000 Stock size: large Treatment: plant or natural seed	Target spp: white spruce Coverage: 25% woody or herbaceous Number of spp.: 5		
Deciduous and Mixedwood Forest – Upland/Transitional	Broadleaf Dense (221)	C23Aw8Sw2	Moist Rich	Soil temperature and competition	5.1	5.8	Aw, Sw	1,400 (Sw)	2,000 (Sw)	1,260 (Sw)	1,800 (Sw)	CWD: 75 m^3/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (white spruce) Final minimal stem density: 1,000 Stock size: large Treatment: plant or natural seed	Target spp: white spruce Coverage: 25% woody or herbaceous Number of spp.: 5	Minimum disturbance and natural regeneration Mounding for access management/microsites • Transitional areas between upland and lowland forests • Target mound density: 400-1,400 mounds/ha • Typical mound density achieved: 700-1,400 mounds/ha CWD rollback for access management • Typical coverage: 250-300 m^3/ha; spread over 50-100 m length spanning width of footprint Conifer seedling planting: • Where there is a conifer component in adjacent stands and where minimal disturbance was not implemented (because minimal disturbance results in rapid natural regeneration of forested stands with a deciduous component) • Target planting density on mounded sites: 2,000-2,500 stems/ha • Target planting density on unmounded sites: 800-1,400 stems/ha • Typical planting densities achieved: TBD with monitoring	(see above – Coniferous Forest)

Project-Specific Information[1]								Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region (AENV 2010)[5]				AESRD Treatment Matrix for Linear Restoration (Vinge pers. comm. 2014)[5]		NGTL Caribou Habitat Restoration – Implementation Lessons from Previous Projects	Preliminary CHRP Potential Restoration Treatment Options
Habitat Types	Land Cover Classification	AVICode[2,3]	Site Type[4]	Limiting Factors	Area (ha)	Percent of Total	Typical Overstory	Planting Density (stems/ha)		Target Density (8 years after planting) (stems/ha)		Treatment Recommendations	Treatment Targets		
Deciduous and Mixedwood Forest – Upland/Transitional (cont'd)	Mixedwood Dense (231)	C29Aw6Sw4	Moist Rich	Soil temperature and competition	0.6	0.7	Aw, Sw	1,400 (Sw)	2,000 (Sw)	1,260 (Sw)	1,800 (Sw)	CWD: 75 m³/ha Mound density: 1,200/ha Planting density: 1,200 stems/ha (white spruce) Final minimal stem density: 1,000 Stock size: large Treatment: plant or natural seed	Target spp: white spruce Coverage: 25% woody or herbaceous Number of spp.: 5	Minimum disturbance and natural regeneration Mounding for access management/microsites • Transitional areas between upland and lowland forests • Target mound density: 400-1,400 mounds/ha • Typical mound density achieved: 700-1,400 mounds/ha CWD rollback for access management • Typical coverage: 250-300 m³/ha; spread over 50-100 m length spanning width of footprint Conifer seedling planting: • Where minimal disturbance was not implemented (because minimal disturbance results in rapid natural regeneration of forested stands with a deciduous component) • Target planting density on mounded sites: 2,000-2,500 stems/ha • Target planting density on unmounded sites: 800-1,400 stems/ha • Typical planting densities achieved: TBD with monitoring	(see above – Coniferous Forest)
Graminoid/ Herbaceous	Herb (100)	--	Wet Rich/Wet Poor (beaver-impounded emergent marsh)	Soil temperature, drainage and nutrients	0.1	0.1	--	--	--	--	--	--	--	Minimum disturbance and natural regeneration	Minimum disturbance and natural regeneration
Anthropogenic	Exposed Land (33)	--		--	0.2	0.2	--	--	--			--	--	Natural regeneration	Natural regeneration

Note:
1 Site-specific conditions will be verified in the field following construction.
2 Alberta Vegetation Inventory (AVI) codes are derived from the Timber Salvage Plan (CH2M HILL 2015). AVI codes are denoted as follows: crown closure [letter code denotes % where A = 6-30%; B = 31-50%; C = 51-70%; D = 71-100%)] / average height [m] / tree species / percent composition [deciled]. For example: AVI code B16Pj10 = crown closure class B / 16 m overstory height / jack pine 100%.
3 Pj = jack pine; Sb = black spruce; Sw = white spruce; Lt = larch/tamarack; Aw = aspen
4 Site type is derived from LCC and project-specific field information, including wetlands classification.
5 Conifer-specific guidelines are reported in the matrix to match the objectives of the CHRP (*i.e.*, Aw and Lt are not included in planting recommendations for being palatable forage for early seral ungulates).

Appendix C

Historic and Current Habitat Restoration Initiatives

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
Consortium composed of oil/gas companies, Environment Canada, ACA, the Alberta Caribou Committee, and AESRD) (previously referred to as Alberta Sustainable Resource Development [ASRD])	CRRP	• Program active from 2001 to the end of 2007. • Mandate was to use an adaptive management approach to restoring caribou habitat while testing methods to speed recovery of man-made linear disturbance. • Involved trials to increase the recovery path of seismic and other linear corridors to treed cover, studying the effect of access management techniques on wildlife and humans, performing a cost/benefit analysis, and drafting recommended operating practices and planning strategies from the construction through to the reclamation phases of oil and gas developments. • Field treatments included: transplanting trees and shrubs, seeding, tree seedling planting, using planting enhancements, soil decompaction, mounding, rollback, and installation of wooden fences for line-of-sight breaks. • Planning strategies included the use of aerial imagery for collecting vegetation inventories, and developing logistical best practices for tree seedling planting in wetland areas during the summer.	• Tested site preparation techniques as they pertain to promoting revegetation and limiting human use of linear corridors, including excavator mounding, decompaction and rollback. • Researched and tested the use of aerial imagery and LiDAR for collecting vegetation inventories on linear disturbances, of which aerial imagery was proven to be successful and adopted for other habitat restoration programs. • Managed the macro-scale Suncor/ConocoPhillips Caribou Habitat Restoration Pilot implemented within the Little Smoky caribou range in 2006: – over 100 km of linear corridors treated, encompassing several townships; – included site preparation techniques (excavator mounding and rollback); – included planting of tree seedlings on a variety of different ecosites, treatment types and disturbances; – included the installation of wooden fences at the beginning of linear corridors to serve as line-of-sight breaks; – focused on access management by using excavator mounding at the beginning of linear corridors; and – installation of signs at treatment sites. • Produced an unpublished draft document on recommended practices for implementing a habitat restoration program, from the planning through to the treatment and monitoring phases. • Produced an unpublished monitoring manual for collecting revegetation data on linear corridors. • Conducted trials of transplanting existing trees under winter and summer conditions. • Sponsored trials of frozen tree seedling planting. • Sponsored trials for the use of encapsulated seed products for reclamation purposes. • Sponsored a line-blocking study, as part of L. Neufeld's Master's Thesis on wolf/caribou dynamics in the Little Smoky caribou range.	CRRP 2007a,b,c Neufeld 2006
Suncor Energy	Accelerated Seismic Line Restoration	Program initiated in 2000. • Objective was to promote revegetation of seismic lines through the use of tree seedling planting, bioengineering (willow staking) and transplanting existing vegetation. • Techniques tried on upland, transitional wetlands and wetland ecosites. • No follow-up monitoring beyond this program.	Four years post-treatment: • upland black spruce transplants survived but showed signs of stress; • black spruce and willow plugs worked better than transplants; • poor results for lines with mulch on them; • transitional wetland black spruce transplanting showed high survival but low growth or vigour rate; and • wetland black spruce and willow transplants and plugs had poor survival, but slightly better survival when planted in elevated microsites.	Golder 2005

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
Canadian Natural Resources Limited (CNRL), Diversified Environmental Services	Ladyfern Pipeline Re-vegetation Program (natural gas pipeline running from northeast BC into northwest Alberta)	Pipeline construction occurred in 2002: • Promoted revegetation on a pipeline development by: minimizing root disturbance during construction; mechanical seeding of the right-of-way on areas of erosion concern only; promoting the growth of native species from seed; planting of tree seedlings; and transplanting of existing trees. • Goal was to create line-of-sight breaks as introduced trees grow over time. • Upland habitat: tree seedlings were planted primarily with white spruce and lodgepole pine. • Lowland habitat: planted larger, locally collected and transplanted black spruce.	• Annual monitoring of species composition and percent vegetation ground cover was conducted for two growing seasons. • Survival rates were higher in upland sites than lowland sites (focus on lowland sites was black spruce transplants). • Poor survival of locally collected transplanted black spruce. • Coniferous tree seedling (nursery stock white spruce and lodgepole pine) survival and growth appeared to be more successful than using locally collected transplants. • Natural regeneration in both upland and lowland sites was noted in areas that had minimized root disturbance during construction of the pipeline and where there was no mechanical seeding of grass seed. • Re-colonization of coniferous species provided the best visual barrier; deciduous species effective more quickly. • Recommended that transplants should be conducted in the fall when trees are dormant, but still have sufficient time to establish roots. • Recommended that the most effective method for establishing a line-of-sight break is to concentrate efforts on productive uplands. • Recommended that smaller trees (20-30 cm) be selected for further transplants.	DES 2004
AXYS Environmental	Recommended Peatland Restoration Techniques for Oil and Gas in Boreal Forest	• AXYS conducted a literature review of successfully used peatland reclamation techniques within wildlife habitats in the boreal forest.	• A mean water table level higher than 40 cm and preferably within 20 cm promotes peatland growth.[1] • Removing drainage ditches following decommissioning will help restore peatlands.[2] • Water table management is essential to ensure successful revegetation of peatlands and to guide the direction of revegetation. Soil chemistry adjustment may be required for problem soils[3]. • To achieve improved black spruce seedling growth and environmental quality, use selected mycorrhizal fungi when reclaiming dense black spruce bogs[4]. • Re-establish site hydrology, site topography, and appropriate bog vegetation to reclaim raised bogs. • Patches of discontinuous permafrost (*e.g.*, in northeastern Alberta) are not yet possible to reclaim[5].	AXYS 2003 [1]Tedder and Turchenek 1996 [2]Girard *et al*. 2002 [3]Naeth *et al*. 1991 [4]Khasa *et al*. 2001 [5]Robinson and Moore 2000 [5]Turetsky *et al*. 2000 [5]Camill 1999
Enbridge Pipelines (Athabasca)	Waupisoo Pipeline Habitat Restoration	Pipeline construction occurred in the winter of 2007/2008. • Promoted revegetation on a pipeline development within critical moose and caribou habitat by: mechanical seeding of the right-of-way on areas of erosion concern only; promoting the growth of native species from seed; planting tree and shrub seedlings; transplanting existing shrubs; and using rollback for access management and micro-site creation for seedling and seed establishment. • Goal was to use growth of planted trees to create line-of-sight breaks, directly restore habitat and manage access.	• Approximately 250,000 seedlings were planted at strategic locations over three summers. Locations included: – intersections with other linear corridors; – upland sites to create line-of-sight breaks; and – riparian areas. • rollback was applied on some steeper slopes and at some intersections with all-season and winter roads. • Shrub species (alder and willow) transplanted successfully on the banks of the Christina River during the winter. • Planting sites are currently subject to monitoring over a five year period. • Good survival of seedlings was observed on upland sites; lowland site seedling survival to be evaluated during monitoring in the fall of 2012. • Vegetation ingress of clover and native grasses has had a negative impact on seedling survival in some areas. • Where no access management measures were applied, human use of the right-of-way by ATV damaged many seedlings. • Seedlings planted in conjunction with rollback were not damaged.	Enbridge 2010 Golder 2011

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
CNRL, Wolf Lake	Interconnect Pipeline	Pipeline construction occurred during the winter of 2007/2008. • Promoted revegetation on a pipeline development adjacent to the Cold Lake Air Weapons Range (CLAWR) by planting of tree and shrub seedlings. • Goal was to use growth of planted tree species to create line-of-sight breaks, limit the overall width of the developed corridor that the pipeline parallels, directly restore habitat and manage access.	• Planting sites are currently subject to monitoring over a five year period. • Approximately 60,250 seedlings planted at strategic locations over two summers. Locations included: – intersections with other linear corridors; – upland sites to create line-of-sight breaks; and – riparian areas. • Good survival of seedlings where mechanical seeding was avoided. • Areas mechanically seeded to native grass mixtures had lower survival and vigour of planted seedlings, possibly due to increased competition for sunlight, water and nutrients, and graminoid vegetation falling over and smothering the seedlings when snowfall occurs. • Damage to seedlings from ATV use in many monitoring plots. • Other environmental factors such as frost and wetland encroachment possibly contributing to seedling mortality.	Golder 2012a
University of Alberta led project, supported by a number of oil/gas companies, Canadian Association of Petroleum Producers (CAPP), Forest Resource Improvement Association (FRIA), and Alberta-Pacific Forest Industries Inc. (ALPAC)	Integrated Land Management	• Ongoing study began in 2004 and focused on contributing to best practices for wellsite construction and reclamation on forested lands in the Green Area of northeastern Alberta. Techniques to enable appropriate revegetation and accelerate recovery of ecological processes after disturbance were studied. • Old wellsites component involved monitoring soils and vegetation. • New wellsites component researched methods to use during well site construction that will promote the prompt revegetation of the site during the reclamation phase.	• Report produced in 2010, “Recommended Practices for Construction and Reclamation of Wellsites on Upland Forests in Boreal Alberta”, that evaluated soil and vegetation responses to different winter construction and reclamation techniques. • Recommendations included: – maximizing low disturbance construction practices; – use of snow/water to level sites as opposed to stripping; – retain root zone when stripping and store soil layers in separate piles; – plant seedlings promptly after reclamation to lessen impact of native vegetation competition; – rollback is preferable to mulching; – mulch layers need to be less than 10 cm thick when present; – avoid planting tree and shrub species that may impact predator/prey dynamics and do not occur naturally in the area. For example, planting of species palatable to moose in caribou areas should be avoided; and – pre-disturbance assessments and prescription planning can pay dividends at the reclamation stage.	Osko and Glasgow 2010
OSLI	OSLI	• Was a collaborative network of six like-minded oil sands developers who aspired to pilot and pioneer collaborative methods focused on accelerating environmental, social and economic performance. Efforts undertaken by OSLI member companies occurred between 2009 and 2013. OSLI had several habitat restoration initiatives, which include the following:	--	COSIA 2012
	Faster Forests	• Began in 2007 to 2013, planting trees to increase the pace of reclamation.	• Planting shrubs along with trees allows for trees to grow healthier, faster and with less competition for nutrients and water from fast-growing grasses. • Planted 143,850 seedlings on 113 sites in 2009. • Planted 238,632 seedlings on 120 sites in 2010. • Planted > 600,000 seedlings in 2011 on 200 sites (included 4 tree species, 7 shrub species).	

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
OSLI (cont'd)	Winter Wetland Planting Trial	• Wetlands revegetation trials consisting of winter planting of black spruce seedlings to address challenges involved with planting disturbed wetland sites during the summer months. • Goal is to improve reclamation performance.	• Planted 900 trees in winter 2011. • > 90% survival rate in spring 2011. • Findings were used to help develop a larger scale frozen seedling program for the on-going Algar Reclamation Program.	COSIA 2012
	Algar Reclamation Program	• Program targeting the restoration of seismic lines through revegetation and access management to improve wildlife habitat in a caribou area with historic seismic disturbance. • The Algar area of northeastern Alberta covers approximately six townships (each township is 6 miles by 6 miles).	• Inventory of linear disturbance completed using remote sensing methods. • Detailed restoration plan developed. • Stakeholder consultation led by AESRD on the closure of selected seismic lines to the general public (*i.e.*, to provide some level of protection to areas with restoration treatments). • Micro-scale restoration activities began in winter 2011/2012 and include: – excavator mounding; – rollback; and – frozen tree seedling planting.	
Alberta School of Forest Science and Management/OSLI	Coarse woody debris management - best practices	• Goal is to come up with consistent standards that industry users can implement when spreading woody debris on reclaimed sites.	• Developed a guide for improved management of coarse woody debris materials as a reclamation resource. • Best practices manual was prepared through consultation with resource managers and operators, consideration of economic and ecologic requirements, and synthesis of the most relevant and current scientific knowledge. • Wood mulch depths exceeding 3-4 cm form an insulating layer over the soil surface limiting plant growth. • Use of whole logs enhances forest recovery by creating microsites, which creates improved conditions for vegetation to establish and grow. • Total rollback of material along the entire length of exploration and access features is the most effective way to discourage recreational use of linear features. • Well-designed scientific monitoring of wildlife use is needed to provide managers with an understanding of treatment effectiveness.	
CNRL	Habitat Enhancement Program	• Program is part of the Terms and Conditions of the *Environmental Protection and Enhancement Act* (*EPEA*) approval for the construction, operation and reclamation of the Canadian Natural Primrose and Wolf Lake (PAW) Project. • Program targeted the restoration of seismic lines, old lease roads, and abandoned well and core hole sites through revegetation and access management to improve wildlife habitat on a caribou range within the CLAWR. • Focused on restoration of historic (pre-oil sands development) features on the landscape that are recovering poorly, either due to environmental conditions (cold, wet soils), historical clearing and reclamation practices, or recent clearing for winter access.	• Used aerial imagery to conduct linear corridor vegetation inventories on all of CNRL's CLAWR operations, encompassing approximately nine townships. • Detailed restoration plan developed. • Ground-truthed sites that appeared on aerial imagery as having little to no woody plant regeneration. • Focused on access management and micro-site creation for introduced tree seedlings, using the following three treatments: – mounding; – tree seedling planting; and – rollback. • Planting sites are subject to monitoring over a five year period. • To date, only monitored black spruce seedlings planted in the summer on sites treated in the winter with excavator mounding in treed bog and fen sites. • Excellent survival and vigour of seedlings after one growing season at all monitored sites.	Golder 2010

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
CNRL (cont'd)	See above	• Focused on areas outside of 10 year development plan to avoid re-entry into areas where restoration treatments are placed.	• See above	See above
ConocoPhillips, Canadian Association of Petroleum Producers and Suncor Energy	Caribou Habitat Restoration Pilot Study	• Remote camera study (summer 2008) initiated within the Little Smoky caribou range in Alberta. Objectives included comparing wildlife (caribou, deer, moose, bear, wolf, coyote, cougar and lynx) presence and use between naturally restored seismic lines and open cutlines.	• Pooled prey species (caribou, deer, moose) preferentially select restored seismic lines (> 1.5 m vegetation heights, average age of trees 23 years) over non-vegetated sites. • Deer had the strongest preference for restored sites, with the preference attributed to the increased forage within the restored sites, as well as reduced line-of-sight and potentially predator avoidance. • Caribou were shown to have a slight preference for revegetated seismic line sites over non-vegetated sites, but with limited data there was no statistical difference. However, caribou on control sites were observed to be running much more frequently than on revegetated sites and engaged in standing related behaviours only while on revegetated sites. Data indicate that caribou are more likely to travel quickly through open seismic lines, which may be a response to the minimal vegetation cover.	Golder 2009
NOVA Gas Transmission Ltd.	Northwest Mainline Expansion CHRP Leismer to Kettle River Crossover Pipeline CHRP Chinchaga Lateral Loop No. 3 CHRP	Pipeline construction occurred during the winter of 2012/2013. • Promoted revegetation on pipeline developments within caribou habitat by: promoting the growth of native species from seed; use of minimum disturbance construction techniques; planting tree and shrub seedlings; transplanting existing shrubs; and using rollback for access management and micro-site creation for seedling and seed establishment. • Goal was to use growth of planted trees to create line-of-sight breaks, directly restore habitat and manage access.	• Detailed caribou habitat restoration plans developed. • Restoration activities began during construction in winter 2012/2013 and continued through final clean-up in winter 2013/2014 for Northwest Mainline and Leismer to Kettle River Crossover. Restoration activities began during construction in winter 2013/2014 and continued through final clean-up in winter 2015 for Chinchaga Lateral Loop No. 3 • Focused on access management and micro-site creation for introduced tree seedlings, using the following three treatments: – mounding; – tree seedling planting; and – rollback. • Seedlings were planted at strategic locations in summer 2014 for Northwest Mainline and Leismer to Kettle River Crossover and planned for summer/fall 2015 for Chinchaga Lateral Loop No. 3. • Chinchaga Lateral Loop No. 3 has a contingency plan for additional planting/staking and/or mounding at select locations, in the event that unforeseen circumstances prevent completion of CHRP measures during 2015. • Habitat restoration measures are subject to monitoring over a 5 year period.	TERA Environmental Consultants 2014a Golder 2014 Stantec 2014
Regional Industry Caribou Collaboration (RICC)	RICC	• An ongoing project in northern Alberta involving the Cold Lake caribou herd is currently investigating the responses of predator and prey species to the deactivation or restoration of habitat disturbance features. • The goal of the project is to determine how different species (wolves, bears, moose and caribou) use the landscape, and how the presence or absence of linear disturbances may influence the functional and numerical response of predators. • A subset of wildlife currently using the study area were collared, and their movement tracked across the landscape, as well as compared between species.	• The project is still in the early stages, and only preliminary results are available; however, the project aims to address several management questions regarding the desired vegetative and spatial characteristics on the landscape to reduce caribou mortality, how silvicultural techniques and mitigative measures can be implemented to achieve these characteristics, the association between specific characteristics and predator efficiency and/or density, and when can deactivated linear features be considered to have lost their disturbance function.	McNay *et al.* 2014

Company or Group	Initiative Name or Goal	Description	Accomplishments and/or Learnings	Key Reports
Canada Oil Sands Innovation Alliance (COSIA)	COSIA	• Program launched in 2012 to enable responsible and sustainable growth of Canada's oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation (COSIA 2012). • Part of the land focus area is a caribou habitat restoration initiative with the goal of improving woodland caribou habitat quality and herd survival through restoration of historic linear disturbances. COSIA has begun several habitat restoration initiatives, which include the following.	• TBD	COSIA 2012
	Algar Historic Restoration Project (Algar)	• Aims to restore linear disturbances using mounding and tree felling. • Takes an integrated regional approach, with six companies working together to repair fragmented habitat across an area of land outside of their actual license areas. • A five-year program to replant trees and shrubs along the linear footprint within the Algar Region, covering an area approximately 570 km^2)		
	Landscape Ecological Assessment Planning (LEAP) tool	• A tool to provide baseline levels of different land use. LEAP can be used to determine the long-term effects of restoration in a given area, which can help guide planting initiatives.		
	The Linear Deactivation (LiDea) Project	Rigorous monitoring and measurement programs have been designed for the life of the Project, and currently include 37,000 ha of active treatment area. • During the spring and summer, conifer seedlings are planted along older seismic lines using specially prepared mounds. • LiDea is also experimenting with forest stand modification, which involves bending tree stems from the adjacent forest across the seismic line to create physical barriers and reduce sightlines along the linear corridor.		

Note: - Table modified from Golder 2012b, TERA Environmental Consultants 2014a.

Appendix D

Project Contact List

Project Contacts	
Jennifer Barker TransCanada Pipelines 450 – 1 Street SW Calgary, Alberta T2P 5H1 Phone: (587) 933-3728 Cell: (403) 437-4905 Email: jennifer_barker@transcanada.com	TransCanada PipeLines Environmental Advisor
AESRD Contacts	
Ed Barnett Environment and Sustainable Resource Development 2nd Floor Provincial Building 4901 – 50 Street Athabasca, AB T9S 1E2 Phone: 780-771-3747 Cell: 780-689-8158 Fax: 780-623-5444 Email: ed.barnett@gov.ab.ca	AESRD Forest Officer, Athabasca
Grant Chapman Environment and Sustainable Resource Development Box 959, 2nd Floor Provincial Building 9503 Beaverhill Road Lac La Biche, Alberta T0A 2C0 Phone: 780-623-5475 Fax: 780-623-4584 Email: grant.chapman@gov.ab.ca	AESRD Wildlife Biologist, Lac La Biche (Township 80, Ranges 14 and 15 W4M)
Joann Skilnick Environment and Sustainable Resource Development 9915 Franklin Avenue Fort McMurray, Alberta T9H 2K4 Phone: 780-743-7258 Fax: 780-743-7155 Email: joann.skilnick@gov.ab.ca	AESRD Senior Wildlife Biologist, Fort McMurray (Township 80, Range 13 and Township 81, Ranges 15 and 16 W4M)

Appendix E

Caribou Observation Form

	Date and Time:
Weather Conditions (temperature, precipitation):	**Location:** **KP:** **GPS:**
Description of Location (e.g., nearest highway, access road or town, seen on a road, in a clearing or in the bush):	
Observation: Number of caribou observed: Calves or young present? (circle one): Yes or No Additional notes:	
Habitat Type: □ sparsely or non-vegetated □ treed wetland □ shrubby wetland □ grass or grass-like wetland	□ deciduous-dominated forest □ coniferous-dominated forest □ mixedwood forest
Recorded by: Telephone:	
Provide this information to NGTL's Environmental Project Supervisor, who will submit it to AESRD Wildlife Biologist (see Appendix B) using a Fisheries and Wildlife Management Information System (FWMIS) loadform.	

Appendix F

Blackline

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION AND ORGANIZATION

1.1 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL), a wholly owned subsidiary of TransCanada PipeLines Limited (TransCanada), received National Energy Board (NEB or Board) Order XG-N081-003-2015 approval on January 28, 2015 under section 58 of the *National Energy Board Act* (NEB Act) for authorization to construct and operate Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station (the Project). For the Project regional location, see Figure 1-1. This Preliminary Caribou Habitat Restoration Plan (CHRP) was prepared for the Project pursuant to NEB Order XG-N081-003-2015 Condition 6 and outlines NGTL's plan to avoid impacts, minimize Project effects on caribou and restore caribou habitat. This document also incorporates feedback received from applicable regulators and technical experts, lessons learned from field experience, industry experience and updated results from ongoing literature review.

The goal of both the Preliminary and Final CHRP will be to minimize "residual effects" of the Project on caribou habitat. Residual effects are environmental effects predicted to remain after mitigation is applied. Tailored to site-specific conditions, mitigation measures related to the disturbance of caribou habitat will be implemented on the Project footprint throughout the pre-construction, construction and post-construction phases of the Project.

The Final CHRP will supplement this Preliminary CHRP by detailing the location and type of restoration that is planned along the Project right-of-way (ROW), and by predicting residual effects requiring caribou habitat offsetting measures. Residual effects presented in the Final CHRP will consider lag time and factor in uncertainty associated with offsets. The approach to validate residual effects predictions (direct and indirect) and restoration success is described in this CHRP, with the detailed adaptive management plan to be described in the Caribou Habitat Restoration and Offset Measures Monitoring Program (CHROMMP). The Final CHRP will be filed on or before November 1 after the first complete growing season following the project being placed into service.

In addition to the CHRP and CHROMMP, NGTL will develop an Offset Measures Plan (OMP) to address Project residual effects on caribou habitat pursuant to Condition 7. The Preliminary OMP will be filed with the NEB at least 90 days before requesting leave to open the Project. The Preliminary OMP will further detail the method used to quantify the offsets

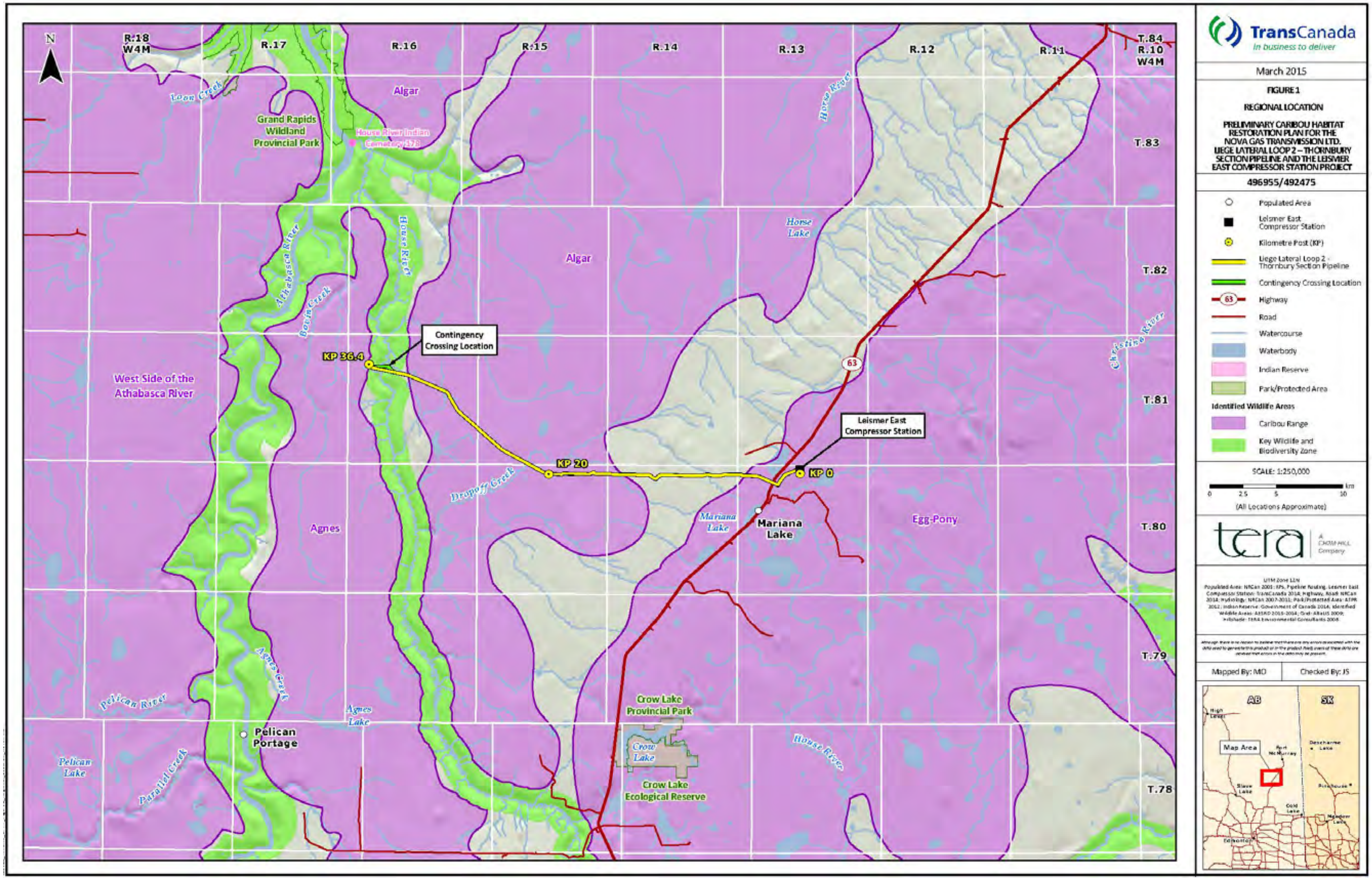


Figure 1-1: Regional Location

1.2 ORGANIZATION OF THE PRELIMINARY CHRP

This Preliminary CHRP is organized in eight sections, as follows:

Section 2: introduces the goal, objectives and quantifiable targets.

Section 3: introduces the habitat restoration decision framework used to prioritize potential caribou habitat restoration sites and to prioritize mitigative actions to be used in different site types, considering typical site factors that could constrain implementation.

Section 4: outlines quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects, the extent to which the goals and objectives have been met, and the need for consequent compensation offsets.

Section 5: describes the CHRP, which includes a description of how the spatial disturbance will be calculated (as the calculation will not be completed until the final CHRP is prepared), habitat restoration, further monitoring details, adaptive management and the implementation schedule.

Section 6: describes how field innovations and experience have been incorporated.

Section 7: provides a summary of caribou-specific consultation with federal and provincial regulators to date, as well as a summary of how feedback was incorporated in the Preliminary CHRP. NGTL will continue to maintain open communication with federal and provincial regulatory agencies, as well as potentially affected communities, through the various Project phases. The Final CHRP will include updated consultation records.

Section 8: is a literature review, on which the decision framework for this document is based, that includes:

- identification of temporal and spatial caribou habitat restoration methods applicable to woodland caribou
- assessment of the relative effectiveness of the identified methods
- description of the literature review approach

The Preliminary CHRP is organized to address each requirement of Order-XG-N081-003-2015 Condition 6. For the locations in this document that outline how each condition has been met, see Table 1-1.

Table 1-1: NEB ORDER-XG-N081-003-2015 – Condition 6: Caribou Restoration Plan

NEB ORDER-XG-N081-003-2015 Conditions	Details and Location in Report
6. Caribou Habitat Restoration Plan (CHRP) NGTL shall file with the Board, for approval, preliminary and final versions of a CHRP for the Project, and shall provide a copy of each version to Environment Canada and Alberta Environment and Sustainable Resource Development (AESRD) at the time of filing with the Board. The CHRP shall comprise:	
a) A preliminary CHRP to be filed at least 90 days prior to commencement of construction, to include but not be limited to: i) the goals and measurable objectives of the CHRP;	Section 2 of the Preliminary CHRP introduces the goal, objectives and quantifiable targets.
ii) the decision frameworks that will be used to prioritize potential caribou habitat restoration sites and to prioritize mitigative actions to be used at different types of sites, including consideration of typical site factors that may constrain implementation;	Section 3 provides a decision framework.
iii) a review of literature upon which the decision frameworks are based including: i. an identification of temporal and spatial caribou habitat restoration methodologies applicable to woodland caribou; ii. an assessment of the relative effectiveness of the identified methodologies; iii. detailed methodology of how the literature review was conducted.	Section 8 of the Preliminary CHRP summarizes relevant literature and describes the method for the literature review.
iv) the quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects, the extent to which the goals and objectives have been met, and the need for consequent compensation offsets;	Section 2 and Section 4 of the Preliminary CHRP describe quantitative criteria to evaluate effectiveness, and include a brief description of monitoring and adaptive management measures. Further information on monitoring and offsets will be provided in the OMP and CHROMMP under separate cover in accordance with Order Conditions 7 and 8.
v) a schedule indicating when measures will be initiated and completed;	Section 5.6 of the Preliminary CHRP provides the schedule for construction and habitat restoration activities.
vi) evidence and a summary of consultation feedback with Environment Canada and AESRD regarding the CHRP; and	Section 7 of the Preliminary CHRP summarizes consultation and feedback on the CHRP from Environment Canada (EC) and AESRD.
vii) evidence and a summary of how consultation feedback with Environment Canada and AESRD is integrated into the CHRP.	Section 7 of the Preliminary CHRP summarizes consultation and feedback on the CHRP from EC and AESRD.

Table 1-1: NEB ORDER-XG-N081-003-2015 – Condition 6: Caribou Restoration Plan (cont'd)

NEB ORDER-XG-N081-003-2015 Conditions	Details and Location in Report
b) A final CHRP to be filed on or before 1 November after the first complete growing season following the commencement of operation of the Project, to include but not be limited to: i) the preliminary CHRP, with any updates identified in a revision log that includes the rationale for any changes to decision making criteria; ii) a table describing caribou habitat restoration sites, including but not limited to location, spatial area, description of habitat quality, site-specific restoration activities and challenges; iii) specification drawings for the implementation of each restoration method; iv) maps or Environmental Alignment Sheets showing the locations of the sites; v) evidence and a summary of how further consultation feedback from Environment Canada and AESRD is integrated into the plan; and vi) a quantitative and qualitative assessment of the total area of direct disturbance to caribou habitat that will be restored, the duration of spatial disturbance, and the aerial extent of the resulting residual effects to be offset, which also includes indirect disturbance.	The Final CHRP will be filed on or before November 1, 2016. For schedule information, see Section 5.6.

2.0 GOAL, OBJECTIVES AND QUANTIFIABLE TARGETS

This section describes the goal, objectives and quantifiable targets of the CHRP.

2.1 GOAL

The overarching goal of NGTL's caribou habitat restoration plan~~planning~~ is to minimize~~reduce~~ the predicted residual effects of the Project and the Project's contribution to cumulative effects on caribou and caribou habitat in a manner that aligns with provincial and federal policies.

2.2 OBJECTIVES

The objectives of the CHRP were designed to achieve the goal in a way that incorporates the best ~~available~~ information~~,~~, available, and can be implemented and can be measured to quantify residual effects on caribou and impacted caribou habitat. The three ~~CHRP~~ objectives of the CHRP are:

1. **Habitat restoration**: revegetation of the Project footprint that achieves establishment, survival and growth of target species in the short term, so natural ecosystems, consistent with adjacent ecosystems, are expected to regenerate over the long term. For example, caribou habitat will be restored ~~within~~ in the Project footprint through revegetation, mounding, bio~~-~~engineering and berms to provide both immediate and sustainable~~ing~~ functional habitat that supports caribou recovery over the long term.
2. **Access control**: effectively discourages access in the Project footprint as an interim measure until results of the monitoring program indicate long-term habitat restoration has been successful. For example, access and use of the ROW is controlled through placement of ~~rollback~~ coarse woody debris, tree felling, ~~and~~ sign placement, and rollback to limit access.
3. **Line-of-sight blocking**: reduce lines-of-sight along the Project footprint using barriers such as screens and vegetation. For example, tree planting, tree felling, vegetative and fabricated site screening are intended to reduce visibility along the ROW.

The CHRP goal to ~~reduce~~ minimize Project residual effects on impacted caribou habitat will be attained by implementing the three objectives identified above. The F~~f~~inal CHRP will assess the objectives from a qualitative and quantitative perspective.

2.3 QUANTIFIABLE TARGETS

Quantifiable targets are the criteria that will be used to determine whether the CHRP objectives identified in Section 2.2 have been achieved:

- extent of predicted residual effects
- whether the CHRP objectives have been achieved
- need for compensation offsets

For more information on quantifiable targets and performance measures, see Section 4.

3.0 DECISION FRAMEWORKDECISION FRAMEWORK

The decision framework (see Figures 3-1, 3-2 and 3-3) will be used to guide the Project in meeting the goal of the CHRP. The decision framework NGTL has developed is a principle based logic model that supports each of the three objectives and forms the basis for quantifiable targets.

The decision framework was initially developed by NGTL from information obtained in the literature review, as well as industry best management practices and industry consultation. However, the decision framework included in this CHRP has been revised to reflect recent lessons learned from field experience on other NGTL projects that impact caribou habitat. In particular, the decision framework has been revised to incorporate lessons learned in implementing line of sight blocks and access control measures on the Chinchaga Project.

The decision framework will be applied at the start of construction to identify candidate sites for mitigation measures and reviewed during construction to identify any changes in inputs. Mitigation will be applied during final cleanup.

Figures 3-1, 3-2 and 3-3 are presented in chronological order of which they are implemented: access control, line of sight blocking and habitat restoration. These figures also show restoration measures or tools that can be applied to the Project footprint in order to meet the CHRP goal. However, only tools applicable to the Project, as restoration measures, will be applied. These are outlined in Section 5, Table 5 3.The decision framework (see Attachment 3 – Figures 3-1, 3-2 and 3-3) is used to guide the Project in meeting the goal of the CHRP. It was developed from information obtained in the literature review, industry best management practices and consultation, and forms the basis for quantifiable targets. The decision framework that NGTL has developed is a principle-based logic model specific to each of the three objectives.

For restoration tools that can be applied to the Project footprint to meet the CHRP goal, see Attachment 3. Only tools applicable to the Project will be applied, as outlined in Section 5, Table 5-2.

Key factors in the choice of these restoration measures or tools include:

- natural site characteristics
- existing disturbance and activities
- regulatory requirements
- site-specific construction methods

4.0 QUANTIFIABLE TARGETS AND PERFORMANCE MEASURES

This section describes:

- quantifiable targets and performance measures used to evaluate the extent of predicted residual effects
- the extent to which CHRP goal and objectives have been met
- the need for ~~consequent~~ compensation offsets for any residual effects remaining after implementation of CHRP measures

For a summary of the quantifiable targets and performance measures available to the Project, see Table 4-1. The quantifiable targets and performance measures selected for the Project work in conjunction with the decision framework described in Section 3.

Table 4-1: Quantifiable Targets and Performance Measures

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Habitat Restoration	• Successful native vegetation re-establishment using the proposed habitat restoration measures will achieve trajectories toward natural ecosystem types, which will eventually re-establish native wildlife habitat. • The Project footprint in caribou range is the proposed clearing of new area (i.e., excludes overlapping/shared areas with existing disturbances). • NGTL's operation and maintenance practice includes vegetation control over the pipe centreline (approximately 6–10 m wide area centred over the pipeline) as a corporate mechanism to meet compliance with CSA-Z662-15. This Standard requires that vegetation is controlled along rights-of-way to maintain clear visibility from the air and provide ready access for maintenance crews (CSA 2015). Although there is flexibility in NGTL's vegetation control practice to allow for wildlife habitat objectives yet remain in compliance with CSA Z662-15, NGTL acknowledges limitations for sustained revegetation success along the pipe centreline while the pipeline is in operation. NGTL understands its obligations for achieving equivalent land capability at end of pipeline life.	Upland Deciduous/~~Mixed Wood~~Mixedwood/Transitional • Achieve ≥80% or higher survival rate for planted seedlings within 15 years following implementation of CHRP measures. • Demonstrate sustained growth trends across ≥80% of restoration locations within 15 years following implementation of CHRP measures. Upland Coniferous • Achieve ≥80% or higher survival rate for planted seedlings within 15 years following implementation of CHRP measures. • Demonstrate sustained vegetation growth trends across ≥80% of restoration locations within 15 years following implementation of CHRP measures.	• Quantitative measures of success will include comparisons of regeneration parameters (e.g., vigour, height, percent cover, species composition) between Years 1, 3, 5, 10, 15 following start of operation, with the objective of ensuring establishment of each habitat type and a trend toward achieving equivalent land capacity. If regeneration parameters are not met, adaptive management measures will be implemented to meet vegetation reestablishment trajectory. It is intended that plantings will be monitored for 15 years. • GPS location, number and type of restoration treatments and the frequency of monitoring sessions will be defined and mapped in the final CHRP.

Table 4-2: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Habitat Restoration (cont'd)	• Areas of the Project footprint that parallel existing footprints with grass cover could have limited successful survival of planted species, due to competition from species ingress from adjacent disturbance. • Overlapping dispositions such as a gravel roads or facilities could limit long-term restoration success.	Wetlands/Treed Lowlands • Achieve ≥50% survival rate for planted seedlings/transplants within 15 years following implementation of CHRP measures. • Demonstrate sustained growth trends across ≥50% of restoration locations within 15 years following implementation of CHRP measures.	• Where revegetation success is inadequate, NGTL will determine an appropriate adaptive management. For example, if seedling mortality is unexpectedly high, NGTL will do additional planting, improve site conditions for seedling success or improve restoration efforts at other sites.

Access Control	• Access control measures are most effective when implemented at intersections of the Project ROW with existing perpendicular linear features (e.g., roads, utility corridors, seismic lines).
	• Access by NGTL staff and contractors, including operations personnel as well as reclamation and monitoring crews, will be recorded and monitored. Access by Project personnel within the footprint in caribou range will be limited to the extent practical.
	• Traditional access might need to be maintained.
		Access Control:
		The following quantifiable targets will be used to measure the access control objective:
		• a lower measure (e.g., rate, proportion, count) of access along the segments of the Project right-of-way where access is controlled relative to uncontrolled segments
		• <20% increase in access (e.g., rate, proportion, count) from the baseline assessment as measured by remote cameras
		• The quantifiable targets for access in the Project ROW are expected to be achieved within 5 years following CHRP implementation, though monitoring will continue over 15 years.
			• Evidence and level of access along Project ROW using criteria ratings such as:
			  ◦ access evident: Yes/No
			  ◦ access type: ATV/ truck/ snowmobile/ non-motorized/
			  ◦ predator/ other
			• Access level: low (tracks/ trail evident but difficult to discern or appears to be infrequently used)/high (tracks/trails appear to be well-used; vegetation is trampled down, bare ground from frequent use might be visible). Access level definitions will be refined in the final CHRP.
			An evaluation of whether the objective for access control is achieved will consider recorded evidence of qualitative and quantitative data.

Table 4-3: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Line-of-Sight Blocking	• There isare no ~~provincial guidelines~~direct provincial regulation in Alberta for line-of-sight management for linear features. Reclamation programs for previous developments in Alberta have targeted maximum sightlines of 400 m (Golder 2007; DES 2004). Operating practices for energy development in sensitive caribou range in BC (BC Ministry of Environment 2011) suggest implementing line-of-sight management every 500 m on linear features that do not share a ROW boundary with a road. • Bends in the pipeline (doglegs) can reduce line-of-sight, but opportunities to do this for the Project might be limited where it parallels other ROWs. • Wetlands and some treed lowlands encountered by the Project footprint naturally have low and/or open vegetation structure. The line-of-sight distance in these areas is naturally long and, therefore, sightline management techniques are not practical for these locations. • Concern from provincial regulators regarding fire hazard and forest health (pathogen spread), availability of material, suitability of substrate to support structures (i.e., peat does not support fencing), introduction of weeds from imported material and potential for alteration in surface hydrology (particularly from earth berms) can limit applicability of this treatment type.	Line-of-Sight Blocking: • Along the Project ROW, in areas of new cut or contiguous Project ROW with NGTL lines only, achieve sightline distance of < 500 m within 15 years following implementation of CHRP measures. • Along the Project ROW, in areas of new cut or contiguous Project ROW with NGTL lines only, where planting for future vegetation screens in combination with or without rollback have been installed, achieve 80% or higher survival rate for planted seedlings that are intended as line-of-sight blocks within 15 years following implementation of CHRP measures. • Where existing linear features intersect the Project ROW (i.e., seismic and other utility ROWs), achieve line-of-sight block distances equal to or less than pre-construction distances.	Establish line-of-sight blocks in forested areas of the footprint in caribou range that will achieve a sightline distance of 500 m or less in areas of new cut or in sections contiguous with, and adjacent to, NGTL lines only.

Table 4-4: Quantifiable Targets and Performance Measures (cont'd)

Objective[1]	Rationale/Limitations/Assumptions	Quantifiable Targets	Evaluation Criteria
Line-of-Sight Blocking (cont'd)	• Appropriate locations for line-of-sight blocks will be identified post-construction when final clearing is complete. • A combination of measures, including vegetation screening, rollback and mounding will be applied. Feasibility of installing berms or fencing will be investigated post-construction. • Fewer limitations are associated with using vegetation screening to reduce line-of-sight. • Paralleling an existing linear corridor presents challenges for line-of-sight blocking where the adjacent line is owned by a different company. Application of sightline management techniques should extend across the width of the Project footprint and adjacent disturbance to be effective.		

Notes:

1 Restoration objectives will continue to be evaluated for the Final CHRP to consider any updated consultation with Alberta Environment and Sustainable Resource (AESRD) now referred to as Alberta Environment and Parks [AEP] ~~AESRD~~ or other information that becomes available.

Available footprint is the area of the Project footprint that is not anticipated to be disturbed by future operation and maintenance activities during the life of the Project.

5.0 THE RESTORATION IMPLEMENTATION PLAN

This section provides a high-level summary of Project impacts to affected boreal woodland caribou habitat. This section also describes NGTL's plan to implement a decision framework (see Section 3) which will be used by the Project to achieve the overarching goal of the CHRP. The content of this section presents NGTL's plan to reduce residual and cumulative effects of the Project on caribou and impacted caribou habitat. ~~This section describes how NGTL will implement outcomes of the decision framework process (see Section 3) for the Project to achieve the overarching goal of the CHRP.~~

5.1 PROJECT IMPACTS TO CARIBOU HABITAT

The Environmental and Socio-Economic Assessment (ESA) for the Project identified potential ~~Project~~ direct and indirect effects of the Project on boreal woodland caribou and boreal woodland caribou habitat through changes in habitat conditions, herd movement and caribou mortality risk. The cumulative effects analysis completed as part of the ESA determined that the Project will ~~Identified Project effects include changes in habitat, movement and mortality risk (CH2M HILL Energy Canada, Ltd. [CH2M HILL] 2014). The pathway of effects will~~ result in ~~the Project having~~ an incremental contribution to the overall cumulative effects on the Egg–Pony and Algar herds of the East Side Athabasca River (ESAR) caribou range. Baseline conditions identified in the ESA will be used to determine the level of vegetation restoration required.

~~For the length of the pipeline portion of the Project construction ROW in caribou range, see~~ The Project linear disturbance presented in Table 5-1 reflects the most recent Project design at the time this Preliminary CHRP was prepared. The pipeline route is located in the Egg–Pony caribou range for approximately 4.9 km, of which 3.1 km (64%) parallels existing pipeline ROWs. The entire length is in an area of historical forest fire that occurred in 1981. The pipeline route is located in the Algar caribou range for approximately 18.9 km, and parallels an existing pipeline, road or seismic line for the entire length. In the Algar caribou range, approximately 12.2 km (65%) of the pipeline route is in an area of historical forest fire that occurred in 1995 and the House River fire that occurred in 2002 (see Figure 5-1). The ROW width will vary based on the workspace and will be reported in the final CHRP.

Table 5-1: ~~Length of Project in~~ Caribou Ranges that Interact with the Project

				~~Length of Route and Percent Parallel~~Project Linear Disturbance in Caribou Range (km)					
Caribou Range	**Alberta Provincial and Federal Status Designation**	**Current Population Trend**	**Caribou Herd**	**Total Length**	**Parallels Existing Road**	**Parallels Existing Pipeline**	**Parallels Existing Seismic Lines**	**Parallels Linear Disturbance**	**New Linear Disturbance**
ESAR	Threatened[1,2,3]	Declining[4]	Egg–Pony	4.9 km	–	3.1 km (64%)	0.1 km (3%)	3.3 km (67%)	1.6 km (33%)
			Algar	18.9 km	1.3 km (7%)	13.4 km (71%)	4.21 km (22%)	18.9 km (100%)	0 km (0%)

Note:
1 Alberta provincial status designation under the *Wildlife Act* (AESRD 2014a).
2 Status designation under Schedule 1 of the *Species at Risk Act* (SARA) (Environment Canada 2015).
3 Status designation by COSEWIC 2015.
4 Population trend reported by Environment Canada 2012.

~~5.1~~5.2 QUANTIFICATION OF HABITAT DISTURBANCE

~~As outlined in Section 8, restoration~~Restoration of disturbed habitat assumes that caribou will return to spatial separation from primary prey (moose and deer) and predators and, as a result, return to pre-disturbance levels of mortality risk (Athabasca Landscape Team 2009). Restoration of anthropogenic disturbances is also expected to reduce the degradation of functional habitat for caribou, since caribou will no longer exhibit reduced use on or near (i.e., in a zone of influence) the reclaimed disturbance (Oberg 2001). As such, restoration of caribou habitat is expected to alleviate the residual direct habitat disturbance over the long term.

By addressing residual direct habitat disturbance, indirect residual effects ~~are~~ will also be addressed. Included in the direct disturbance footprint ~~for~~ are the ~~Project in caribou range are the pipeline~~ ROW, ~~and~~ temporary workspace, compressor station site and new permanent access (see Figure 5-2). The Final CHRP will provide schematics that illustrate the quantification of direct and indirect residual effects of the Project on caribou habitat using as-built information. Indirect disturbance (i.e., reduced habitat effectiveness) is defined as the area within the 500 m buffer of anthropogenic disturbance features.

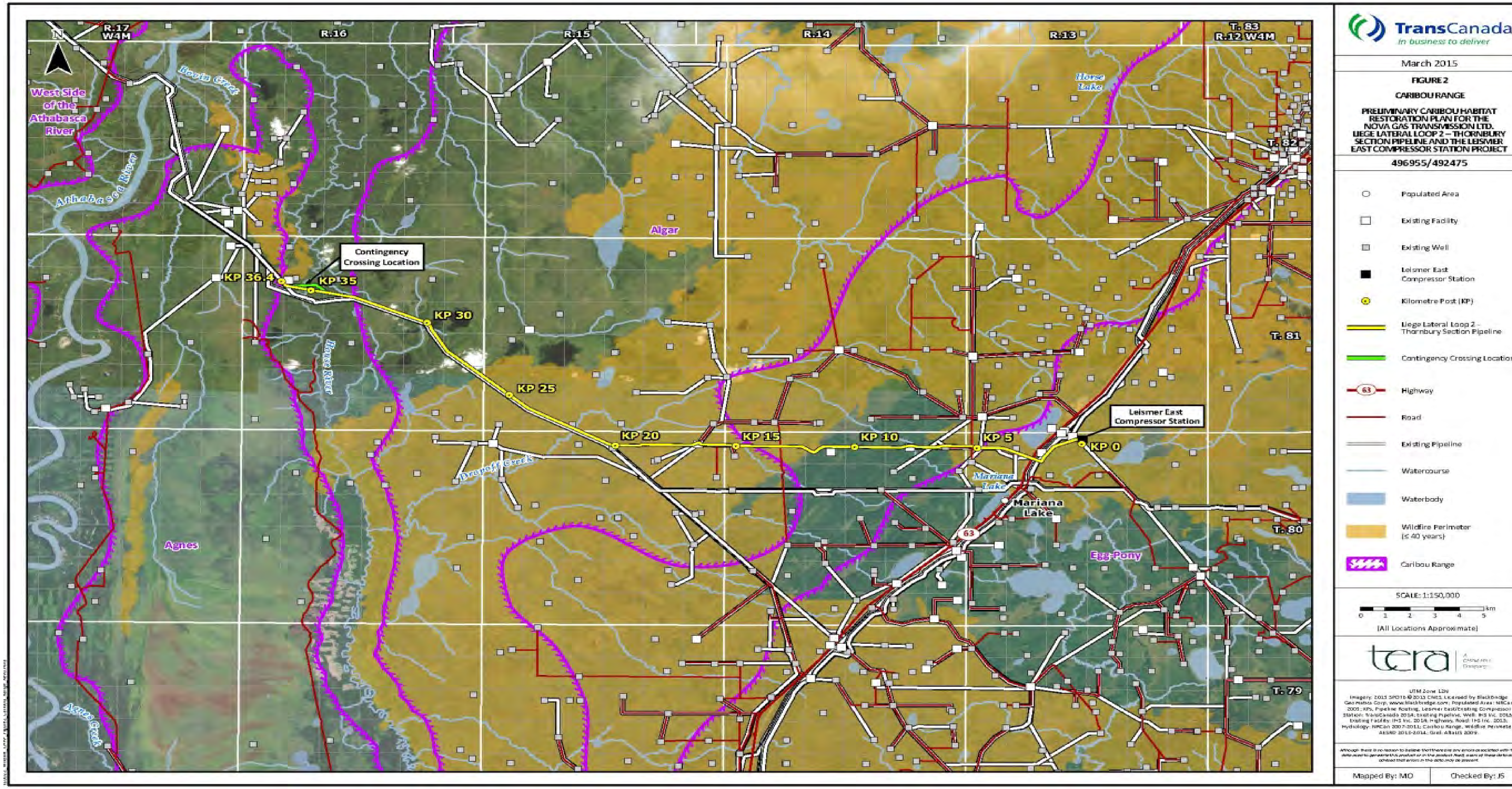


Figure 5-1: Caribou Range

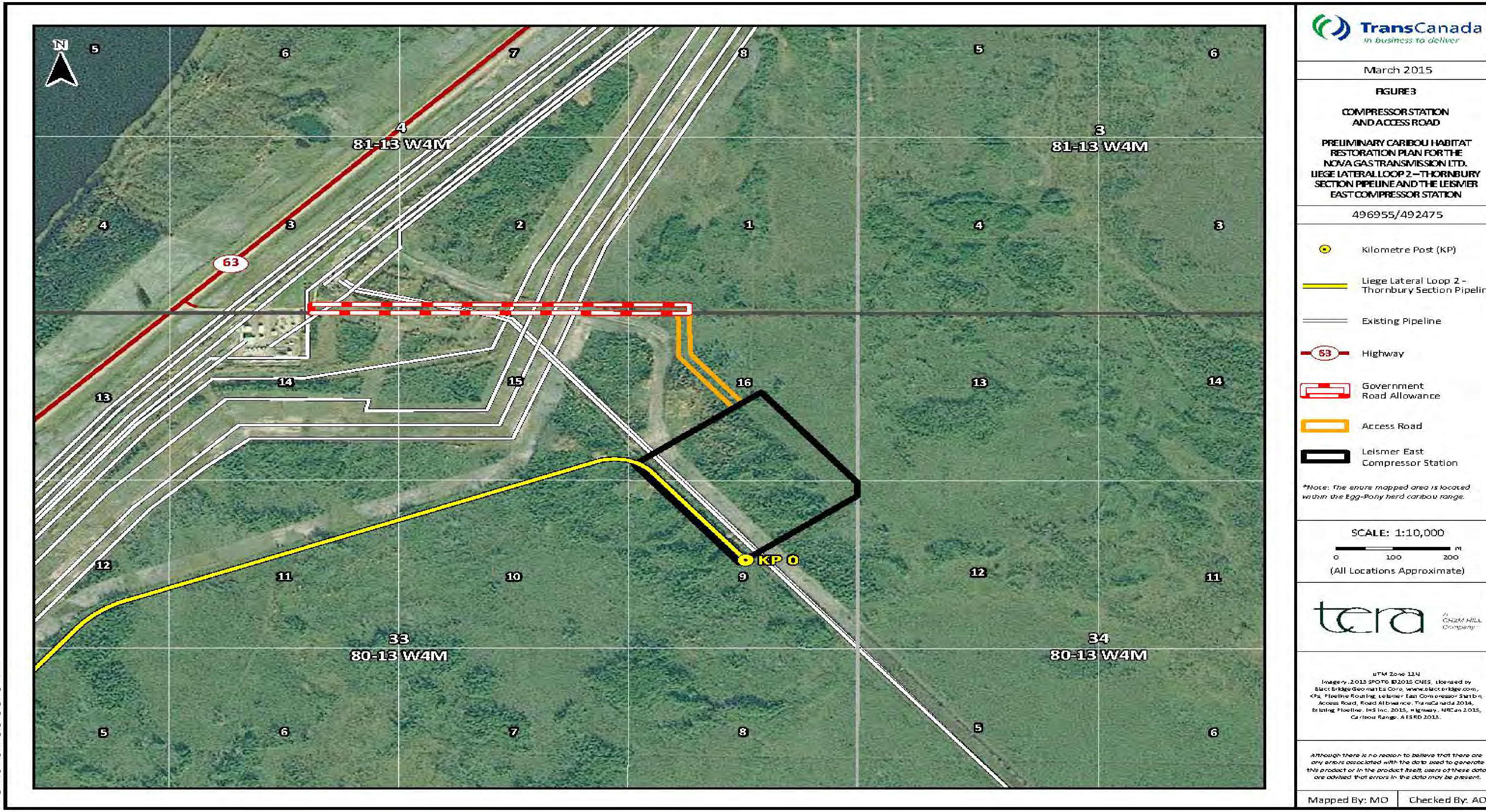


Figure 5-2: Compressor Station and Access Road

The spatial residual effect will be quantified using a method consistent with *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* (Environment Canada 2011, 2012). The Recovery Strategy defines undisturbed caribou habitat in the Environmental Site Assessment Repository (ESAR) caribou range as habitat that has not burned in the last 40 years and is not in or within 500 m of anthropogenic disturbance. Although the Project footprint is in an area that has been burned ~~due to~~by forest fires within the last 40 years, NGTL will still consider this non-permanent disturbance in its quantification of spatial residual effect.

Restoration of ~~habitat in~~ the impacted ESAR caribou ~~range~~habitat through implementation of the CHRP measures will not completely eliminate adverse Project effects on caribou habitat. During operations, NGTL will periodically manage vegetation within 5 to 10 m of the centreline of the operational pipeline, in accordance with TransCanada operational procedures for integrity monitoring under Canadian Standards Association (CSA) Z662-15 (CSA 2015).

This area will be allowed to regenerate naturally, but will be periodically mowed or mulched. This theoretical access area will not achieve the quantifiable targets for the CHRP and is quantified as a residual direct disturbance of caribou habitat.

After application of the CHRP measures outlined in this document, the final disturbance footprint will be determined. Direct and indirect Project disturbance on caribou habitat will be quantified and presented in the Final CHRP, as outlined in Table 5-2.

Table 5-2: Quantification of Direct and Indirect Project Disturbance of Caribou Habitat

	Area (ha)			
	Direct Project Disturbance	Restored Project Footprint	Residual Direct Project Disturbance	Incremental Indirect Disturbance
Length of Pipeline Segment	TBD	TBD	TBD	TBD

The proportion of total area for each mitigation measure in each habitat type will be used to estimate the remaining Project effect using the following equation:

Calculation 5-1:

$$Remaining\ Project\ Effect\ (ha) = Inherent\ Project\ Effect\ (ha) \times \{1 - (Measure\ Effectiveness\ \times Delay\ Penalty)\}$$

To calculate the final offset requirement for the Project, the first step involves calculating the remaining project effect after CHRP measures are applied to the Project footprint. The restored Pproject footprint will be categorized ~~into the portion of inherent project effect that is~~ as either new alignment or parallel alignment. New alignment is assumed to have full effect on caribou use of this part of the range utility, whereas segments parallel to adjacent disturbances have less effect on range caribou use utility (this will be further outlined in the OMP).

The second step (inherent project effect) involves categorizing the portion of total area for new alignment and parallel alignment into their respective habitat classes to apply the appropriate delay factors (i.e., time lags) associated with each mitigation measure.

The third step categorizes the proportion of total area for each mitigation measure within each habitat type.

The proportion of total area for each mitigation measure within each habitat type will be used to estimate the remaining Project effect using the following equation:

$$Remaining\ Project\ Effect\ (ha) = Inherent\ Project\ Effect\ (ha) \times \{1 - (Measure\ Effectiveness \times Delay\ Penalty)\}$$

The remaining project effect calculation will be used to populate Table 5-2 in the Final CHRP.

Table 5-2: Quantification of Direct and Indirect Project Disturbance of Caribou Habitat

	Area (ha)			
	Direct Project Disturbance	Restored Project Footprint	Residual Direct Project Disturbance	Incremental Indirect Disturbance
Length of Pipeline Segment	TBD	TBD	TBD	TBD

For previous NGTL projects that impacted caribou habitat, NGTL allowed has updated its operational standards to allow for intermittent alternating plantings of woody vegetation over the pipeline centreline. For the ProjectSpecifically, trees will be planted across the centreline with where open areas are left at alternating sides of the ROW along some sections. This will allow for a meandering access line over the centreline, and will in time, establish line-of-sight breaks (i.e., vegetation screens). Using this alternating planting method the quantifiable targets for habitat restoration (revegetation) are expected to be achievable in the long term.

The entire width of the Project planted footprint , therefore, is will not be considered restored in planted segments, and the short term. In the short term, there will be a spatial residual effect on the area of operational access. residual effect can be effectively addressed once the habitat regenerates in the long term. In the long termother words, the area of operational access is not considered expected to be a spatial residual effect where the ROW segment is planted with trees. The spatial residual effect is expected to be effectively addressed once the habitat regenerates in the long term.

Some The restoration measures to be applied in the Project footprint are designed to be effective immediately or in the short term. For example, retention of vegetated visual screens, mounding and tree felling (particularly if in conjunction with mounding) are expected to reduce Project residual effects on caribou habitat immediately.

The lag time required to achieve habitat value equivalent to pre-construction conditions is important and will be considered in the quantification of residual effects in the Final CHRP. Residual effects presented in the Final CHRP will consider spatial residual effect; lag time and the uncertainty associated with offsets (see Calculation 5-1). Over the long term, the vegetation community composition and structure is expected to mature to a seral stage that will provide functional caribou habitat and restore pre-disturbance predator–prey dynamics.

NGTL will develop an OMP to address Project residual effects on critical caribou habitat, in accordance with Condition 7. The Preliminary OMP will be filed with the NEB at least 90 days before requesting leave to open the Project. The Preliminary OMP will further detail the method used to quantify the offsets. Residual effects presented in the Final CHRP will consider lag time and factor in uncertainty associated with offsets. The Project OMP will use a method of offset quantification that aligns with NGTL's previous OMPs for projects constructed in boreal woodland caribou range. Residual effects will also be presented in the Final CHRP and will consider lag time and factor in uncertainty associated with offsets.

The residual effects to be quantified in the Final CHRP using the method described above will be modified in the calculation of residual effects in the OMP to factor in:

- uncertainty associated with effectiveness of the CHRP measures
- context of the footprint related to existing disturbance (e.g., contiguous or non-contiguous)
- time lag or duration of residual effects

5.25.3 HABITAT RESTORATION

The dDecision fFramework summarized in (see Section 3) and regulatory guidelines summarized in Section 8 provide the basis for the Preliminary CHRP and will further guide the Final CHRP. The dDecision Ffframework provides direction on restoration factors such as variability in natural site characteristics, planting prescriptions, target vegetation, soil and site stability, and access management. This in--turn also informs the quantifiable targets and performance measures that will be used to evaluate the extent of predicted residual effects and the extent to which goals and objectives have been met.

For a suite of caribou habitat restoration measures, see Table 5-3. After applying the d~~D~~ecision f~~F~~ramework, suitable restoration measures will be selected. ~~Restoration measures will be selected considering NGTL's experience with previous caribou habitat restoration initiatives, as well as habitat and construction.~~ Several ~~of the~~ methods described in the literature review and included in Table 5-3 are considered not suitable given the limitations to implementation or effectiveness. These measures could be reconsidered, ~~however,~~ if additional information becomes available to support their use.

For photos of potential restoration measures, including site conditions showing constraints and opportunities, see Appendix A.

Site-specific caribou habitat restoration measures implemented for the Project will be described in the Final CHRP, ~~along with~~ which will include maps or Environmental Alignment Sheets showing the locations of selected sites.

For an illustrative ~~sample~~ table showing ~~the~~ site-specific restoration methods and location details that may~~will~~ be included~~updated~~ in the Final CHRP, see Appendix B. The Final CHRP table will also include the rationale for restoration measure selection, additional site-specific details to inform implementation and implementation status. Accomplishments and lessons learned from implementing and monitoring NGTL's other caribou habitat restoration initiatives will be included in the Final CHRP, and will inform the rationale for selection of restoration methods and locations. The Final CHRP will also include specification drawings of the restoration measures, in accordance with Condition 6b(iii).

Table 5-3: Habitat Restoration Measures

Restoration Measure	Objectives	Rationale	Comments
Berms	Access control Reduce line-of-sight	Berms can be constructed of coarse woody debris and timbers, or a combination of coarse woody debris and earth. Supported berms are constructed using timber cleared from the ROW. To effectively block line-of-sight, berms should be constructed to an approximate minimum height of 1.5-2 m. Promote rapid shrub/tree regeneration at ends of berms (e.g., shrub staking/transplants, seedling planting) to increase effectiveness as access control. Earth berms were 76% effective at excluding vehicles over 50 inch in width and 22% effective at excluding all vehicles including off-road vehicles (Esri User Conference 1996). Berms create a barrier that can be effective immediately following implementation. Coarse woody debris/timber berms are dependent on approval from provincial authorities to retain coarse woody debris on-site, as well as sufficient space to store the material during construction. Woody debris berms may present an increased fire hazard, depending on composition and location. NGTL has found on its existing ROWs where this measure was used, that woody debris berms deteriorate relatively quickly after installation (within several years), particularly if berms are moved to allow access to the ROW. Availability of source material is usually not sufficient for earth berm construction in areas where minimum disturbance construction techniques are employed. Importing material is not preferred given the risk of introducing invasive plants. Earth berms should not be located in peatlands due to potential for settling and alteration of surface hydrology.	Limitations of this measure reduce its value. Woody material available for inclusion in berms is often limited, so can make this option less useful. Woody debris berms might be used as CHRP measures if sufficient wood exists at the Project site. Earth berms will not be considered a viable option for the Project as NGTL has found that there is generally insufficient source material to create earth berms.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Bioengineering – shrub staking/planting or tree seedling planting	Habitat Restoration Access control Reduce line-of-sight	Bioengineering in combination with stabilization measures (e.g., soil wraps) might be suitable at watercourses crossed with an open cut method. It is the use of existing live vegetation to stabilize and revegetate a site (e.g., transplants; installing cuttings) and is a technique often used on slopes or riparian banks (Polster 2002). Species and planting densities used for bioengineering are site dependent (Golder 2012a). Vegetation used is typically collected either from the disturbance site (i.e., before or during clearing), or from the adjacent area, in the form of cuttings (Golder 2012a). Vegetation may be planted during the growing season or during winter. Willows and poplar can be used as cuttings. Both species are fast growing, which establishes line-of-sight breaks quickly and works well for riparian restoration (Golder 2012a). Nursery-grown shrub seedlings may be planted where staking is not practical due to lack of available material, limitations associated with collecting material off-site, or where a restoration prescription calls for shrub planting of species that do not readily regenerate through cuttings/staking (e.g., alder). Alder has low browse value for ungulates such as moose and deer. Compacted sites that are difficult to treat using mechanical site preparation methods can benefit from inter-planting alder with conifers. When alder is interspersed with conifer plantings, line-of-sight and human access on linear features can be reduced relatively quickly (compared to conifers alone). The nitrogen-fixing characteristics of alder can provide soil enhancement (Sanborn et al. 2001; Sweeney 2005), potentially promoting improved conifer growth over the long-term (Courtin and Brown 2001; Simard and Heineman 1996). The fast growth of alder can reduce growth rates of conifer plantings due to competition when alder densities are high (CRRP 2007b; Simard and Heineman 1996). Species are determined based on the adjacent forest stand and restoration objectives (e.g., low palatability for ungulates). Combined plantings of shrub and tree seedlings can be appropriate, depending on site conditions and anticipated natural revegetation of both species. Procurement of shrub seedlings (container or bare-root) can be challenging given limited seed availability. Planted shrubs can be slow to establish.	Shrub planting is a suitable CHRP measure for select site-specific locations if a need for combined conifer/shrub plantings is identified. Many shrub species can attract prey species such as moose and deer which can attract wolves thus its application will be limited as these species can have a negative effect on caribou (see Section 8).

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Conifer seedling planting	Habitat restoration Access control. Reduce line-of-sight	Species are determined based on the biophysical characteristics of the site, adjacent forest stand composition, and restoration objectives (e.g., low palatability for ungulates). Tree seedling planting is considered a long-term restoration treatment (effectiveness is expected to take longer than 10 years). Planting densities for reclamation of forested areas in Canada have been based on forestry standards, ranging from 1,500-2,500 stems/ha (MacDonald et al. 2012). The Government of Alberta (AESRD 2013b) *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* is unclear in its recommendations, stating that the expected planting density for sites planted with merchantable species is 2,000 stems/ha and vegetation assessments conducted at least two growing seasons after planting are expected to have a minimum stem density of 2,000 stems/ha. This allows for no seedling mortality. The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010) specify ranges of planting densities that vary by the site type and tree species planted. For example, to achieve medium to dense crown closure, the planting density of conifer (pine and white spruce) seedlings in dry, moist poor or moist rich site types is 1,400-2,000 stems/ha. In wet poor sites, the recommended planting density of black spruce is 1,400–2,800 stems/ha. The *Reforestation Standard of Alberta* (AESRD 2014b) is specific to reforesting cutblocks and defines successful regeneration as having 80% stocking of acceptable trees during establishment surveys conducted 4 to 8 years after harvest (i.e., 80% of sample plots have at least one live conifer tree 30 cm tall or taller, or one live deciduous tree that is at least 130 cm tall). This gives a minimum target stem density of approximately 800 stems/ha. Given the relatively harsh growing conditions inherent to boreal ecosystems, mortality of planted seedlings is anticipated to range from approximately 5% to 20% in most site types (Golder 2012a,b). A planting density of 2,000–2,500 stems/ha has been recommended for restoration of linear disturbances in boreal caribou ranges in northeastern BC (Golder 2015). A linear restoration matrix developed by AEP~~AESRD~~ recommends a planting density of 1,200 stems/ha in boreal caribou range in Alberta (Vinge unpublished). Given the densities were developed for forestry practices and this project relates to linear ROWs, the monitoring program might show a reduced success rate and the survival target might need to be adjusted over time.	Conifer seedling planting is a suitable CHRP measure for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Conifer seedling planting (cont'd)	Habitat restoration Access control. Reduce line-of-sight (cont'd)	Based on the above information and also considering Alberta ecosystems, the following planting prescription has been formulated for this CHRP: • minimum live seedling density of 1,600-2,000 stems/ha on sites that are not mounded; • minimum live seedling density of 1,200-2,000 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites (dependent on mound density)	
Mounding	Restore vegetation (create microsites) Access control	For the purposes of enhancing microsites for planted seedlings, mounding is a well-researched and popular site-preparation technique in the silviculture industry. It is commonly used in wet, low-lying areas to create better-drained microsites to enhance seedling survival. Mounding treed wetlands (e.g., bogs, fens) can enhance a site to promote natural revegetation over time, as higher, drier spots are created that seed can eventually settle into and germinate (Golder 2012a; Macadam and Bedford 1998). Soil properties (e.g., substrate, drainage) affect the ability of mounds to retain their structure. Mounding has been used as an access control measure on old roads and seismic lines to discourage off-road vehicle activity. It can be effective immediately following implementation. For access control purposes, mounds should be created using an excavator to approximately 0.75 m deep, where site conditions allow (Golder 2012a). The excavated material is dumped right beside the hole (Macadam and Bedford 1998). Suggested densities of mounding for access control or microsite creation purposes vary from 1,200 to 2,000 mounds/ha (AENV 2010; Golder 2012a; Vinge unpublished). Implementation of this mound density may be suitable for restoring disturbances such as seismic lines where specialized equipment is used, and where frost is not driven into the soils to allow heavy equipment access. The mound density that can realistically be achieved on pipeline ROWs is lower since mounding is completed in conjunction with final cleanup. The limitations include scheduling mounding for restoration during final cleanup, which typically requires freezing-in of soils, availability of specialized equipment and minimum spatial separation of 5 m between mounds and the centreline of the operating pipeline. For previous NGTL caribou habitat restoration projects on pipeline ROWs, the achievable range in mound density was approximately 700-1,400 mounds/ha.	Mounding is a suitable CHRP measure that will be used in conjunction with conifer seedling planting for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Minimum disturbance construction	Habitat Restoration Reduce line-of-sight	Construction during winter conditions reduces the need for soil salvage and grading, and the width of grubbing is limited to the trench area where grading is required. Reduced disturbance to vegetation and root systems is achieved by cutting, mowing or walking down and mulching shrubs and small diameter trees at ground level. The intact root systems and seed bed with little soil disturbance facilitates rapid regeneration of vegetation. Use of snow padding or matting can limit the need for cutting or mowing shrubs and small trees, thereby speeding regeneration of native vegetation. The extent of minimum disturbance construction is limited by scheduling to avoid the restricted timing window for caribou (February 15 to July 15) and also. by existing ground topography. Soil conditions limit the applicability of minimum disturbance construction methods. Construction in well to moderately drained sites during non-frozen conditions requires grubbing and grading to salvage surface soils so they can be stored separately from subsoils and replaced following construction. This prevents admixing and loss of the productive surface soils that facilitate regeneration of vegetation.	Minimum disturbance construction is a suitable CHRP measure for the Project, and will be implemented where scheduling, ~~and~~ soil conditions (e.g., frozen), and topography allow.
Transplanting	Habitat Restoration Access control Reduce line-of-sight	Transplanting has the advantage of immediately establishing relatively large trees/shrubs (e.g., saplings). There are limitations to transplanting, including inconsistent availability of vegetation suitable for transplant, potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands, transplanting programs often result in the storage of plant materials under less-than-ideal conditions due to uncontrollable factors (i.e., weather) and other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison (Golder 2012a).	Transplanting of native vegetation is not a suitable CHRP measure for the Project as it has been shown to be a difficult technique to implement on a large scale, with marginal results and multiple limitations. This technique could prove more suitable for future projects if advances in the method improve survival success rates.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Tree felling or bending	Access control Habitat Restoration Reduce line-of-sight	Mechanically bending or felling live trees onto the linear disturbance has been tested as a measure to restore habitat and manage access on seismic lines in caribou range (COSIA 2012).Trees are typically bent or felled from both sides of the linear disturbance. Tree felling involves deliberately felling trees over the linear disturbance. It does not require specialized machinery and. will be considered where adjacent trees are tall enough. Tree bending requires specialized machinery to mechanically bend live stems over the linear disturbance. Mechanical tree bending can be expensive and time consuming. These measures are often used in conjunction with other restoration techniques such as mounding and conifer seedling planting. Tree felling/bending is only initially being evaluated and its utility remains unverified (Neufeld 2006). It is recommended that if tree felling is to be used as a line blocking measure, it should be investigated more thoroughly, and not solely be relied on as a mitigation tool (Neufeld 2006). Preferably, line-blocking with tree felling (or tree bending) should be used in combination with other management actions such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. Tree felling/bending can promote natural revegetation by increasing cone deposition onto the ROW, creating microsites through shading and dropped dead woody debris, and protecting planted seedlings from extreme weather, wildlife trampling and damage from access. Application in pipeline ROWs might be limited due to the width (i.e., much wider than typical seismic lines where tree bending/felling has previously been implemented). Furthermore, NGTL has narrowed the construction ROW for the Project to minimize the footprint as much as site conditions and construction requirements allow, leaving inadequate space for tree retention along the edges of the footprint for tree felling. The narrowed permanent ROW does not include space for tree retention along edge of the ROW and requires trees to be felled from beyond the limits of a typical ROW as the edge of ROW is inherently variable due to spatial distribution of trees. Provided regulatory permitting (e.g., temporary field authorization to fell trees adjacent to the approved construction ROW) could be obtained, this measure could be a valid option for non-contiguous portions of the Project footprint.	Tree felling may be an option for the CHRP; however, due to the uncertainty of its effectiveness and limitations to application to pipeline ROWs, its application will be on a limited and/or trial basis for the Project. Another consideration for tree felling is the amount of available trees that can be used for the technique and that will be determined after final construction. Tree bending is not a suitable CHRP measure for the Project, given constraints associated with specialized machinery and time necessary to implement. As well, this technique is still being studied and as new research on the technique emerges, it could be considered for future projects.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Tree/shrub seeding	Habitat Restoration Access control Reduce line-of-sight	Species and application rates required are site dependent. Seeding is considered a long-term restoration treatment. Given the relatively narrow disturbance associated with linear developments such as pipeline ROWs in forested landscapes, native seed dispersal readily covers the disturbed area. Conifer cone crops can vary dramatically from year to year, and in some areas good cone crops are relatively predictable (given documented cycles and climatic conditions). Seeding could be a suitable measure if poor cone crops are expected for several years following reclamation, or if target species differs from the adjacent stand. Accessibility (i.e., distance to airport) can be a technical limitation if seeding is to be conducted aerially. Seed predation is also a limitation of applying tree seed.	Seeding is not a suitable CHRP measure, given logistical constraints (i.e., availability of native seed, accessibility of seeding equipment) and likelihood of native seed ingress from vegetation in the adjacent undisturbed areas.
Coarse ~~Woody~~ woody debris	Access control Habitat restoration Reduce Line of Sight	Coarse woody debris rollback can be used for access control and to enhance restoration of natural habitat characteristics. Woody debris rollback can enhance revegetation as it can conserve soil moisture, moderate soil temperatures and provide nutrients as debris decomposes, prevent soil erosion, provide microsites for seed germination and protection for introduced tree seedlings (Pyper and Vinge 2012; Vinge and Pyper 2012). Fine woody debris (e.g., chipped or mulched debris) can be detrimental to soil thermal conditions, carbon:nitrogen (C:N) ratios and plant recruitment where the depth of debris is excessive (AENV 2010). Mulch depths less than 3 cm are preferred to avoid limiting natural ingress and vegetation growth (Pyper and Vinge 2012; Vinge and Pyper 2012). Coarse woody debris should be spread evenly across the entire width of the footprint at a coverage/density that will not restrict ability to plant seedlings or limit planted or natural seedling growth. Woody debris should be applied at a density/volume that does not exceed 400 tonnes/ha to discourage access along a ROW (Osko and Glasgow 2010). Where sufficient material is available, woody debris coverage can range from 60-100 m^3/ha on upland sites and 25-50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012). Where sufficient material is available, woody debris coverage of 150–250 m^3/ha along ROWs might be appropriate to manage access (Vinge and Pyper 2012). Coarse woody debris rollback blocks constructed at 500 m intervals can be used as reducing line of sight measures. To allow operational access, the blocks consist of three segments placed in a staggered pattern approximately 10 m apart.	Woody debris rollback is a suitable CHRP measure for the Project.

Table 5-3: Habitat Restoration Measures (cont'd)

Restoration Measure	Objectives	Rationale	Comments
Woody debris (cont'd)	Access control Habitat restoration (cont')	Research presented at the North American Caribou Workshop (2014) suggested that application of high densities (200 m^3/ha) of salvage logs (i.e., rollback) at linear feature intersections reduces human use by 100%, wolf use by 90% and deer use by 50%. NGTL has found on previous caribou habitat restoration projects that coverage ranging from 200–300 m^3/ha can deter access while allowing sufficient spaces between the debris to allow seedling planting. Rollback can be effective immediately following implementation, provided adequate material is available and properly applied (Vinge and Pyper 2012). The implementation and length of a rollback segment is dependent on sufficient quantities of coarse woody debris during clearing of new disturbance and the trade-off between its use and the ability/space to store it during construction (CRRP 2007b). Long rollback segments are more effective at managing human access because ATV riders will be less inclined to try to ride through the debris or traverse around it in adjacent forest stands. Sections of rollback ≤ 100 m in length may not be effective at deterring motorized access (Vinge and Pyper 2012). An expert opinion survey cited 400 m long rollback segments as sufficient length (Golder 2007). Guidelines for application of rollback where materials are available recommend placement of rollback across the entire pipeline/easement width for a distance of at least 200 m from all points of intersection with wellsites, plant sites, roads and permanent watercourses (AER 2013). NGTL has found on previous caribou habitat restoration projects that material availability often limits the segment length that can be achieved to 50–100 m (75 m on average). Fire risk is a consideration when using or storing materials for rollback. Fire risk can be minimized through proper storage and placement of materials (Pyper and Vinge 2012). A 25 m rollback-free fuel break placed at 250 m intervals along rollback segments is is recommended by the *Integrated Standards and Guidelines for the Enhanced Approval Process* (AER 2013).	Woody debris rollback is a suitable CHRP measure for the Project.

~~5.2.1~~5.3.1 Natural Regeneration

Minimum disturbance construction is a promising approach for promoting native vegetation re-establishment. Minimal disturbance procedures relate to the removal of vegetation, work area preparation and clean-up activities associated with construction of the Project. The objective of this construction technique is to minimize impacts on the soils and vegetation substructure, with the goal of allowing the Project footprint to re-vegetate to a similar pre-construction condition, subject to land-use guidelines specific to the disposition. NGTL will, therefore, implement minimal disturbance construction techniques to facilitate natural regeneration ~~and~~to restore habitat along the ROW. This construction technique is restricted to areas where grading is not required. Stripping and grading will be required in areas of significant cross-fall of the ROW (i.e., greater than 1.0 m), irregular ground profile along the pipeline, and at tie-in sites (road bores and pipeline crossings). Minimal disturbance installation is most suitable for straight pipe installation. ~~Minimum disturbance construction is a promising approach for promoting native vegetation re-establishment.~~

~~5.2.2~~5.3.2 Tree Planting

Established reclamation and forestry reforestation practices will be applied to promote revegetation where natural regeneration might not achieve the quantifiable targets. Restoration measures that incorporate tree planting techniques, such as site preparation (e.g., mounding) and planting trees/shrubs, will be considered where site conditions allow (including construction methods and level of disturbance).

For a summary of habitat types that will be disturbed as a result of the Project footprint, see Table 5-4. For the planting prescription for each habitat type, see the performance measures identified in Table 4-1.

Table 5-4: Habitat Types ~~along the Pipeline Route~~ in ESAR Caribou Range

Habitat Types	Ecosystem Description~~Land Cover Classification~~	Area (ha)	Percent of Total (%)
Treed Wetland	Wetland – Treed (81)	23.5	26.5
	Total	23.5	26.5
Shrubby/Herbaceous Wetland	Wetland – Shrub (82)	14.4	16.3
	Wetland – Herb (83)	17.2	19.4
	Total	31.6	35.7
Upland/Transitional Coniferous Forest	Coniferous Dense (211)	19.4	21.9
	Coniferous Open (212)	8.1	9.1
	Total	27.5	31.0
Upland/Transitional Deciduous and Mixedwood Forest	Broadleaf Dense (221)	5.1	5.8
	Mixedwood Dense (231)	0.6	0.7
	Total	5.7	6.5
Graminoid/Herbaceous	Herb (100)	0.1	0.1
	Total	0.1	0.1
Anthropogenic	Exposed Land (33)	0.2	0.2
	Total	0.2	0.2
All Habitat Types	**Total**	88.6	100

Implementation targets and specifications for habitat restoration (e.g., seedling planting densities, mounding densities) will be designed to meet the quantifiable targets for the CHRP. These will be informed by available guidelines and standards (see Section 8), NGTL's experience implementing caribou habitat restoration measures and complementary research.

~~These and the~~ For the planting prescription for each habitat type, see the quantifiable targets column in Table 4-1. The quantifiable targets and performance measures in Table 4-1 should be considered preliminary and subject to change. The restoration methods and targets will be affected by variables such as extent of grading, construction method and availability of shared workspace and access. The proposed habitat restoration quantifiable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends of conifer and deciduous trees within 15 years following completion of restoration. These targets are to be met over the portion of the Project footprint available for restoration (i.e., excluding overlap with third-party developments or operational access outside planted areas).

~~5.3~~5.4 ACCESS CONTROL

The goals of access control for the Project in caribou habitat are to:

- manage access along the pipeline ROW in a manner that discourages all forms of access
- maintain accessibility necessary for safe pipeline operations compliant with applicable regulations and guidelines
- maintain existing access at identified locations (e.g., third-party industry access, traditional access identified by Aboriginal communities through engagement activities)

5.4.1 Baseline Data on Access Control

Geographic Information System (GIS) will be used to mark selected locations of monitoring plots in order to establish the baseline assessment for this Project. The locations will be chosen based on a review of the Project's construction alignment sheets and proposed access control treatment locations.

Based on early review of the Project's spatial configuration, 32 existing linear features (for example, seismic lines, utilities corridors or roads) have been identified that intersect with the Project ROW. NGTL will control access where the Project intersects active crossings, and will assess these areas as potential treated sites.

An assessment of these potential control sites will include the deployment of Reconyx remote cameras over a six week period. However, several of the sites cross wetlands with little or no trees and may not be good candidates for access control treatments.

The Final CHRP will outline a detailed review of the baseline access study and further detail the final locations of the monitoring plots.

5.4.2 Access Control Measures

Access -control measures are most effective when implemented on non-contiguous segments of the pipeline portion of the Project's ROW, and at intersections of the pipeline portion of the Project's ROW with existing perpendicular linear features (e.g., roads, utility corridors, seismic lines). Quantifiable targets and criteria used to evaluate the effectiveness of access ~~management~~ control measures will align with those in the CHROMMP.

Access -control measures that will be considered for the Project, but not necessarily utilized, include:

- extended bored crossings
- vegetation screens
- rollback
- fencing and signs
- vegetation planting
- mounding
- installation of berms
- tree felling over the ROW

Rollback, mounding and planting vegetation will be the key access -control measures implemented for the Project. Some of these measures might not be selected for final restoration because of site-specific conditions. For example, lack of materials necessary for the installation of berms could limit the applicability of berm installation for this Project. ~~due to site-specific conditions. For example, extended bored crossings are still being considered for the Project. The suitability for extended bored crossings depends on the type of forest understorey and will be determined during the early stages of clearing. Fencing was also considered for the Project but restricting access to Crown lands would have resulted in stakeholder concerns.~~

Locations for access -control measures on the pipeline ROW will focus on intersections with other linear features, such as roads, utility ROWs, seismic lines or watercourses and non-contiguous sections of the ROW. NGTL might install signs at select locations to discourage access.

~~5.4~~5.5 LINE OF SIGHT BLOCKING

Line-of-sight blocks include planting vegetation (e.g., tree planting or willow staking), fabricated site screens and minimal disturbance construction to preserve vegetation. Line-of-sight blocks will be implemented in locations with sightlines >500 m, particularly where they intersect with existing road access. Trees will be planted in an alternating pattern across the pipeline centreline along portions of the ROW. Specifically, trees will be planted across the centreline with open vegetation left at alternating sides of the ROW along some sections. This alternating vegetation pattern will create a line-of-sight break. Details on exact configuration of seedling planting to achieve line-of-sight breaks depend on as-built location of the pipe centreline and adjacent linear disturbances.

Measures to reduce sightlines might discourage access and might also decrease predator efficiency. In nature, sightlines are often longer in more open habitats of lowland muskeg communities compared with upland forest communities. As a result, line-of-sight distances can vary, depending on the location and structure of the adjacent vegetation community. In forested areas of the Project footprint where sightlines are 500 m long or ~~greater~~more, line-of-sight blocks will be established.

There are no provincial guidelines in Alberta for line-of-sight management for linear features. Reclamation programs for previous developments in Alberta have targeted maximum sightlines of 400 m (Golder 2007; DES 2004). Operating practices for energy development in sensitive caribou range in BC (BC Ministry of Environment 2011) suggest implementing line-of-sight management every 500 m on linear features that do not share a ROW boundary with a road (see Section 8). As science is still emerging in this area, the long term monitoring of this and other NGTL CHRP measures, will be modified based on monitoring results to determine the appropriate line of sight breaks.

NGTL has implemented ~~a~~ 500 m line-of-sight breaks to be consistent across provincial boundaries regardless of the location of the pipeline segment and has incorporated this approach in other Project CHRPs. Previously, NGTL attempted to apply the line of sight and access control features on the landscape as suggested in the Alberta Energy Regulator (AER) Enhanced Approval Process (EAP); however, it has become apparent that over the course of implementing those features on other NGTL projects that impact caribou habitat (Leismer, NWML, Chinchaga) meeting the recommended intervals was not feasible. In particular, recent field experience on the Chinchaga Section provided several examples of why these features cannot be applied at EAP recommended intervals. For lessons learned on other NGTL projects about implementing line of sight blocking intervals see Section 6.3.

~~As science is still emerging in this area, the long-term monitoring of this and other NGTL CHRP measures, will be modified based on monitoring results to determine the appropriate line-of-sight breaks.~~

Topography, bends in the ROW, minimum disturbance construction to preserve vegetation and willow staking create immediate line-of-sight blocks (i.e., create visual barriers after restoration activities are implemented). Line-of-sight measures such as tree plantings will be implemented in areas where sightlines are not blocked by terrain or bends. Planting at staggered intervals across the pipeline centreline will establish these 500 m line-of-sight breaks in the long term.

The exact locations for implementing line-of-sight breaks ~~are currently being~~will be determined after construction and ~~will be~~ presented in the F~~f~~inal CHRP.

~~5.5~~5.6 MONITORING AND ADAPTIVE MANAGEMENT

NGTL will create a CHROMMP for the Project to monitor effectiveness of planned habitat restoration measures that will be fully described in the Final CHRP. Adaptive management, i.e., the systematic process of monitoring and assessing outcomes and modifying restoration measures if necessary, will be implemented by adjusting and/or supplementing restoration measures, where warranted, to achieve the objectives of the CHRP.

Given that science is still emerging on caribou habitat restoration methods and effectiveness, adaptive management principles will be an important means of addressing uncertainty.

Monitoring will be ~~completed~~ conducted for up to 15 years, starting one~~a~~ year after CHRP measures have been implemented. At each monitoring interval ~~(see Section 5.6)~~, performance measures will be evaluated and compared with quantifiable restoration targets. If measures indicate that restoration has achieved or is on a trajectory to achieving targets, no further ~~mitigation~~ restoration measures will be undertaken~~completed~~. If, however, at any point in the monitoring program evaluations ~~measures~~ indicate that targets are unlikely to be achieved after 15 years, restoration measures ~~mitigation~~ must be adjusted and additional monitoring (longer than15 years) ~~must be done~~added.

This could include implementation of existing ~~mitigation (e.g., see Section 4.2)~~ restoration measures or new measures~~mitigation~~, discovered through research or industry practice, that are~~is~~ proving to be successful. For example, NGTL is engaged in linear feature restoration research with the Regional Industry Caribou Collaboration in northeastern Alberta and lessons learned from this research can be applied to the Project.

Monitoring results, as well as any necessary adaptive management actions, will be reported to the NEB, Environment Canada and AEP ~~AESRD by~~ following the end ~~of Q1~~ following each monitoring interval.

Habitat restoration measures that require adaptive management at the conclusion of the 15-year monitoring program will require additional ground-based monitoring until they are successful. If adaptive management actions fail, a revised monitoring program and timeframe will be developed to address unsuccessful measures and their locations.

The previous sections of thisThis Preliminary CHRP includes brief descriptions of the restoration targets and how they will be measured. The Final CHRP will detail the actual habitat restoration methods implemented and their locations in the Project footprint. The residual disturbance to critical caribou habitat resulting from the Project will be calculated and finalized in the OMP for the Project. Specific details on the quantitative framework of the monitoring program methods, frequency, timing and locations will be included in the CHROMMP. The CHROMMP will describe a comprehensive monitoring program for Project CHRP measures and potential offset areas, as finalized in the OMP, to compensate for alteration of residual effects in caribou habitat through residual effects.

5.7 QUANTITATIVE FRAMEWORK

NGTL will implement a monitoring program to verify the effectiveness of CHRP and OMP measures and plans to integrate monitoring outcomes into future decision-making as part of a continual improvement process. The monitoring program will employ a quantitative framework using both aerial and ground-based sampling protocols to assess the effectiveness of habitat restoration, access control and line of sight blocking measures. As discussed above, specific details concerning the monitoring program methods will be discussed in the CHROMMP. The following provides a brief example of the quantitative framework used to assess habitat restoration effectiveness (i.e., revegetation) in upland/transitional coniferous forest as a preliminary guide.

5.7.1 Experimental Design

A one-way repeated measures experimental design will be used to evaluate restoration effectiveness for each individual habitat type separately due to the inherent differences associated with their biophysical characteristics. Repeated measure designs are generally preferred over other factorial designs as they improve the precision of estimates derived on the response variable (Montgomery 2001; Kuehl 2000). Quantifiable targets associated with each restoration measure collected during the monitoring program will be repeated at each monitoring plot location for each monitoring year. The experimental design is represented by the following model:

$$y_{ik} = \mu + \alpha_i + \tau_j + \varepsilon_{ij}$$

where y_{ik} is the estimated response of the quantifiable target, μ is the overall mean, α_i is the effect of each monitoring year, τ_j is the effect of each monitoring plot and ε_{ij} is the natural variability (i.e., error) (Montgomery 2001). The model term τ_j denotes the repeated measure effect associated with each monitoring plot, each monitoring year. The degree to which restoration measures achieve their respective targets will be determined by a positive difference of the mean for each quantifiable target between each monitoring year, where the first monitoring year will act as a baseline.

5.7.2 Results

Table 5-5 provides an example subset of data for upland/transitional coniferous forest with vegetation height (m) as the quantifiable target. To illustrate the proposed repeated measure design, statistical analysis and results, the following example is demonstrated for five sample plots across five monitoring years.

Table 5-5: Example Data Subset for Upland/Transitional Coniferous Forest (Vegetation Height)

Monitor Plot ID	Habitat Type	Description	Location (KP)	Monitoring Year	Vegetation Height (m)
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	1	0.19
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	1	0.13
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	1	0.15
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	1	0.19
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	1	0.16
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	2	0.22
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	2	0.16
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	2	0.22
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	2	0.26
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	2	0.27
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	3	0.41
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	3	0.48
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	3	0.49
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	3	0.40
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	3	0.40
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	4	1.20
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	4	1.12
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	4	1.32
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	4	1.41
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	4	1.36
Liege U 1	Upland/Transitional Coniferous	Pl, Sw	3 + 350	5	2.10
Liege U 2	Upland/Transitional Coniferous	Pl, Sw	18 + 875	5	2.23
Liege U 3	Upland/Transitional Coniferous	Pl, Sw	27 + 850	5	2.56
Liege U 4	Upland/Transitional Coniferous	Pl, Sw	32 + 425	5	2.80
Liege U 5	Upland/Transitional Coniferous	Pl, Sw	34 + 300	5	2.65

Habitat restoration is achieved when a positive increase in mean vegetation height is observed between the first monitoring year (i.e., baseline) and each subsequent monitoring year. As such, the analysis focuses on the mean difference in vegetation height for the fixed effect monitoring year, with monitoring plots treated as random effects to control for natural variability associated with each monitoring plot.

Table 5-6 provides a summary of the model output and pairwise comparisons used to identify differences in mean vegetation height between the first monitoring year and each subsequent monitoring year. In the example, a significant difference is observed for the fixed effect monitoring year (*p*<0.001). Pairwise comparisons of mean vegetation height (m) between the first monitoring year and each subsequent year demonstrate a positive increase in mean vegetation height between each monitoring year, with the exception of the second monitoring year (*p*=0.940). Ongoing review and monitoring comparisons will be integral in determining if vegetation targets can be met and then can be used in effectiveness determination.

Table 5-6: Example Results for Upland/Transitional Coniferous Forest (Vegetation Height)

Model Output

Factor	Type	Levels	Values
Monitoring Year	Fixed		1, 2, 3, 4, 5
Monitor Plot ID	Random		Liege U 1, Liege U 2, Liege U 3, Liege U 4, Liege U 5

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Monitoring Year	4	19.073	4.7683	282.80	**<0.001**
Sample Plot ID	4	0.1493	0.0373	2.21	0.113
Error	16	0.2698	0.0168		
Total	24	19.492			

Pairwise Comparisons of Mean Vegetation Height (m)

Monitoring Year	N	Mean Vegetation Height	Grouping
5	5	2.468	A
4	5	1.282	B
3	5	0.436	C
2	5	0.226	CD
1	5	0.164	D

Means that do not share a letter are significantly different.

Monitoring Year Comparison	SE of of Means	Simultaneous Difference	Adjusted 95% CI	T-Value	P-Value
2 – 1	0.062	0.0821	(-0.1894, 0.3134)	0.75	0.940
3 – 1	0.272	0.0821	(0.0206, 0.5234)	3.31	**0.031**
4 – 1	1.118	0.0821	(0.8666, 1.3694)	13.61	**<0.001**
5 – 1	2.304	0.0821	(2.0526, 2.5554)	28.06	**<0.001**

~~5.6~~5.8 SCHEDULE

Scheduling and logistical coordination before restoration implementation will consider seasonal access constraints, ~~sensitive~~ critical timing periods for caribou and other valued components, production of nursery seedlings and appropriate timing for restoration efforts (e.g., season of planting). ~~Baseline information has been compiled (e.g., vegetation cover/habitat).~~

~~Initial rough~~Final cleanup activities will be completed following construction and ~~final cleanup will be completed~~ within one year ~~of~~ following the start of operations. As-built construction information will be compiled following construction and used to determine appropriate site-specific restoration measures and access control locations. Final site selection for caribou habitat restoration treatments will be completed ~~early~~ during the first ~~winter~~ growing season following construction.

~~Scheduling caribou habitat restoration measures that require onsite equipment (e.g., mounding, placement of woody debris for rollback) will be coordinated with final cleanup of the Project footprint during frozen conditions.~~

For the current proposed schedule for construction and habitat restoration activities, see Table 5-5.

5.8.1 Caribou Timing Windows

NGTL is employing an early in/early out strategy to reduce disturbance of caribou by initiating activities as early as possible in the winter and working expeditiously to limit late winter activities.

Clearing activities at the compressor station will be complete and the site will be fenced prior to February 15, 2016, after which work will generally occur within buildings. Pipeline access preparation and clearing will commence in mid-September 2015 as conditions allow, and will be completed prior to February 15, 2016. NGTL is committed to reporting construction progress to the regulators on a bi-weekly basis so they are informed of any circumstances that may lead to delays with the construction schedule.

Final clean-up and reclamation is scheduled to occur in early winter 2017 during frozen conditions and in the late summer, outside the February 15 to July 15 timing restriction.

Table 5-6: Liege Lateral Loop 2 Construction and Habitat Restoration Schedule

	2015												2016												2017											
	Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4			Q1			Q2			Q3			Q4		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Caribou Timing Window																																				
February 15 to July 15																																				
Clearing, Construction and Clean-up																																				
Clearing and construction of the compressor station site and access road																																				
Pipeline access preparation, right-of-way and temporary work space clearing in the Egg-Pony and Algar Caribou Ranges																																				
Pipeline construction in the Egg-Pony and Algar Caribou Ranges																																				
Final clean-up																																				
Caribou Habitat Restoration																																				
Planning Prelim. CHRP and access management																																				
Camera deployment for baseline access control data collection																																				
Field assessments and planning Final CHRP																																				
Seedling procurement																																				
Nursery seedlings grown																																				
Site preparation and access management implementation																																				
Shrub staking, bio engineering (riparian areas) and seedling planting																																				

6.0 CONTINUOUS IMPROVEMENT

This Preliminary CHRP has incorporated updated results from ongoing literature assessment, research completed by industry associations, lessons learned from previous NGTL projects, consultation with applicable regulators and resource managers, and adaptive management practices in the field.

This section describes caribou habitat restoration initiatives, industry collaboration and lessons learned by NGTL on other projects with caribou habitat. Continuous improvement comes from NGTL's analysis of the monitoring program (short term), applied practice (near term) and pure research (long term).

6.1 CARIBOU HABITAT INITIATIVES

Although restoration ecology specific to caribou habitat is a relatively new science, some key initiatives have identified important lessons learned related to oil and gas development in caribou range. Common among many of these initiatives are lessons learned on which plant species to use, when and where to replant, development of effective techniques to promote natural revegetation and a better understanding of methods to manage access. Lessons learned from these initiatives were incorporated in large-scale habitat restoration projects near Grande Prairie, Cold Lake and Fort McMurray, Alberta, as well as NGTL's projects in caribou habitat.

These initiatives focused on revegetation and access management, as well as limiting growth and establishment of plant species favourable to primary prey (e.g., Caribou Range Restoration Project [CRRP] 2007a,b; Golder Associates Ltd. [Golder] 2010; Osko and Glasgow 2010). Projects also included tree planting initiatives, coarse woody debris management best practices, habitat enhancement programs and habitat restoration trials in caribou range (CRRP 2007a,b; Enbridge Pipelines [Athabasca] Inc. [Enbridge] 2010; Golder 2010, 2011; COSIA 2012).

Blocking line-of-sight is a tool implemented through land use guidelines to mitigate increased risk of predation in the short term, while longer-term goals of revegetation of sightlines are achieved.

6.2 INDUSTRY COLLABORATION

Canada's Oil Sands Innovation Alliance (COSIA) was launched in 2012 to enable responsible and sustainable growth of Canada's oil sands while delivering accelerated improvement in environmental performance through collaborative action and innovation (COSIA 2012).

The organization's four key focus areas are tailings, water, land and greenhouse gases. Part of the land focus area is a caribou habitat restoration initiative with the goal of improving woodland caribou habitat quality and herd survival through restoration of historic linear disturbances.

COSIA has developed the following habitat restoration initiatives:

- Determining effectiveness of different restoration techniques such as winter tree planting, mounding, seeding and placement of coarse woody debris. The winter tree planting trial was set up to determine the effectiveness of planting black spruce seedlings in wetland areas during winter. Results of the tree planting trial indicated 90% survival of the 900 seedlings planted.
- Development of the Landscape Ecological Assessment Planning (LEAP) tool to provide baseline levels of varying land use. LEAP can be used to determine the long-term effects of restoration in a given area, which can help guide planting initiatives.
- The Algar Historic Restoration Project takes an integrated regional approach, with six companies working together to repair fragmented habitat across an area of land outside their actual licence areas. This is a five-year program to replant trees and shrubs along the linear footprint in the Algar Region, covering an area approximately 570 km^2.
- The LiDea Project aims to restore linear disturbances using mounding and tree felling. Rigorous monitoring and measurement programs have been designed for the life of the project, and currently include 37,000 ha of active treatment area. During spring and summer, conifer seedlings are planted along older, mounded seismic lines. LiDea is also experimenting with forest stand modification, which involves bending tree stems from the adjacent forest across the seismic line to create physical barriers and reduce sightlines along the linear corridor.

The Regional Industry Caribou Collaboration (RICC) is part of COSIA, and is a multi-industry partnership focused on restoring caribou habitat through regional, collaborative, range-based efforts. The objectives of RICC are to coordinate habitat restoration in the short term and long term, coordinate future activity, support and lead scientific research, conduct applied trials and align caribou habitat restoration programs with provincially led Range Plans and Action Plans.

NGTL has recently joined RICC. A major RICC research effort is to verify the effectiveness of restoration measures using a multi-scale predator/prey collaring program to address current knowledge gaps in habitat use and function. As new information on habitat restoration becomes available, NGTL will incorporate it in the planning and implementation process for its projects in caribou habitat.

6.3 LESSONS FROM NGTL HABITAT RESTORATION

Preliminary and Final CHRPs were completed for NGTL's Northwest Mainline Expansion Project, Leismer to Kettle River Crossover Project and Chinchaga Lateral Loop No. 3 Project (Chinchaga Section). Based on NGTL's experience with these three projects, the following lessons learned were incorporated in this Preliminary CHRP:

- ~~Coarse woody debris~~Rollback was used as firewood by land users when stacked as ladders. A more random arrangement of wood piles to discourage wood removal might be used in the future.
- Line-of-sight breaks on co-located ROWs are not effective because of unrestricted access on parallel ROWs. NGTL has learned that such methods are better used in non-contiguous ROWs and that such line-of-sight breaks are redundant on contiguous ROWs. There have been structural stability issues with ~~constructive~~ constructed line-of-sight blocks (versus vegetation screens). NGTL has, therefore, been experimenting with constructing alternative line-of-sight structures (e.g., snow fencing constructed with 2x4s was tested during winter 2014/15).
- Tree planting on a linear corridor appears to ~~be~~ not be as effective as on cutblocks (typical silvicultural practices) because of shading. This could result in changes to the planting densities and configurations as the monitoring program progresses.
- Access control cannot be absolute because of safety, operating and maintenance activities that must occur. On previous NGTL projects, lack of access resulted in CHRP measures being destroyed or removed by TransCanada staff to access the ROW. In the future, access-control locations will be strategically placed to allow for maintenance and traditional use access.
- Where CHRP measures have failed or been removed, they have been replaced as part of adaptive management.
- As NGTL has attempted to apply the line of sight/access control features on the landscape as suggested in the EAP; however, it has become apparent that over the course of implementing those features on other NGTL projects that impact caribou habitat (Leismer, NWML, Chinchaga) meeting the recommended intervals was not feasible. For further details about why NGTL has not adopted the EAP suggested intervals, see Section 5.5.
- Based on recent field experience on the Chinchaga Section with implementing access control and line of sight blocks, NGTL determined that there are several reasons why these features cannot be applied at EAP recommended intervals and the intervals that were identified within the decision framework from the Chinchaga Final CHRP:

- Materials to construct line of sight blocks are not often available and limit the capacity to implement at the EAP recommended intervals (for example, 200m and 400m):
  - There would be insufficient woody material to implement line of sight blocks, even using merchantable timber, to construct these features every 200m to 400m.
  - There is often not enough suitable material to implement rollback at the EAP recommended intervals.
  - Limited opportunities to implement mounding due to the unsuitability of soil types and ecosite type.
- Conflicting interests for timber and woody materials:
  - Timber salvage waivers must be approved prior to construction and acceptable to the Forest Management Agreement (FMA) holder
  - In regards to woody materials, merchantable timber is prioritized first and used for access control then the remaining materials go to FMA.
  - Any woody materials remaining must be distributed efficiently among the locations where CHRP measures are required (line of sight blocks, mounding).
  - Often NGTL has experienced a lack of available material to implement CHRP measure at 500m intervals.
- Operational concerns:
  - From a safety and maintenance perspective, implementing CHRP measures at 200m and/or 400m makes operational access difficult and potentially unsafe in case of an emergency situation precious time would be lost removing the access control and line of sight measures.
  - For Leismer in particular, NGTL personnel had issues gaining access to the ROW as a result of access control measures. These measures were then removed to gain access. However, the integrity of the wood feature had degraded so replacement of the feature was not possible. There were no additional replacement materials available to reconstruct the feature.

7.0 CONSULTATION

This section summarizes NGTL's caribou-related consultation with EC and ~~AESRD~~ AEP for the Project (see Table 7-1).

NGTL began consultation and working collaboratively with provincial regulators, Aboriginal communities, stakeholders and industry partners several years ago at the outset of the Project and will continue to work with provincial and federal regulators to align the CHRP measures with provincial and federal policies.

This Preliminary CHRP was developed based on ongoing consultation with EC and ~~AESRD~~AEP. NGTL will continue to work with ~~AESRD~~ AEP to identify and address caribou-related concerns before construction, and will continue to facilitate open communication throughout Project execution.

A draft Preliminary Caribou Management Plan (CMP) was provided to federal and provincial regulators for review. The CMP was replaced by this Preliminary CHRP following receipt of draft Conditions from the NEB. The key recommendations from EC were to reduce the Project footprint by paralleling existing linear features and avoid sensitive periods for caribou. In June 2015, NGTL received extensive feedback from ~~AESRD~~ AEP on the Preliminary CHRP, which has been incorporated in this document. General concerns included:

- use of ambiguous language
- lack of clear definition of quantifiable targets and performance measures
- adherence to restricted activity periods (RAP)
- implementation of a caribou monitoring plan

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Environment Canada				
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	June 18, 2014 June 27, 2014 July 18, 2014 Email	June 18, 2014: NGTL provided project description and proposed schedule to EC and inquired about starting work at the compressor station during the caribou timing restriction. June 27, 2014: EC stated that mitigation principles should be in accordance with the following hierarchical sequence: avoidance, mitigation and compensation/offset for any residual environmental effects that cannot be avoided or sufficiently minimized. July 18, 2014: NGTL stated that NGTL is awaiting provincial guidance on whether clearing at the compressor station can occur within the caribou timing restriction.	5.6 4,5,6,7 5.1	The schedule is provided in Section 5.6. The mitigation hierarchy is applied to the CHRP, and is reflected in the measures described in Section 4 to Section 7, which span pre-construction (planning), construction, post-construction (restoration) and operations phases. Offsets will be addressed in the OMP and CHROMMP as per Conditions 7 and 8. Timing windows are discussed in Section 5.1.
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	February 3, 2015 Email	NGTL stated that an NEB approval has been received (Order XG-N081-003-201). NGTL stated that they are committed to completing a CHRP, an OMP and a CHROMMP for the Project. NGTL asked how EC would like to be consulted with respect to these plans. EC would like to review all caribou management plans.	1.2	The Preliminary and Final CHRP will be provided for EC review. NGTL plans to also provide EC the OMP and CHROMMP for review.
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	March 30, 2015 Email	Draft Preliminary CHRP sent to EC for review and comment.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Environment Canada (cont'd)				
Paul Gregoire Head Program and Planning Coordination, Canadian Wildlife Service	April 17, 2015 Email	EC reviewed the Preliminary CHRP and had few concerns overall. EC identified concern regarding the method used to quantify residual effects in burned areas, and the implications for quantifying offsets. EC advises that some burned areas might be only 10 years from providing good habitat and the Project could set this area back another 30 years. Therefore, burned areas should not be excluded entirely from the quantification of residual effects and offsets. Additionally, EC advised that there will be a considerable time lag before the plantings in restored areas are effective, and this should be considered in the determination of residual effects and offsets.	6.2	NGTL will quantify direct and indirect spatial residual effects in the Final CHRP. The method to quantify residual effects has been clarified in Section 6.2 since the draft version of the Preliminary CHRP reviewed by EC. The temporal aspect of the residual effects will be discussed in the Final CHRP, and will be incorporated in the method used to determine offsets (e.g., offset ratios reflect time lag considerations).
Alberta Environment and Parks ~~Sustainable Resource Development~~				
Steven Stryde Forest Officer Ed Barnett Forest Officer Wandering River, AB David Lind Land Management Planner Lac La Biche, AB	April 9 and 15, 2013 April 24 and 25, 2013 Email Telephone	NGTL provided factsheet and overview of Project. NGTL requested a time to meet and discuss Project details.	–	N/A
David Lind Land Management Planner Lac La Biche, AB	May 1 and 2, 2013 Email	NGTL followed up with meeting request.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks ~~Sustainable Resource Development~~ (cont'd)				
Ed Barnett Forest Officer Wandering River, AB David Lind Land Management Planner Lac La Biche, AB	May 16, 2013 Meeting	NGTL provided a Project overview. There is currently no AESRD contact for receipt of the CMP. May 17, 2013: NGTL provided AESRD with the meeting minutes.	–	N/A
Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	July 16, 2013 Telephone, Email	NGTL provided a Project overview and requested a discussion about the Project CMP. AESRD requested that information also be provided to Joann Skilnick.	–	N/A
Grant Chapman Senior Wildlife Biologist Lac La Biche, AB Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	September 25, 2013 Email	NGTL provided AESRD a Project overview and update.	–	N/A
Ed Barnett Forest Officer Wandering River, AB Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	January 31, 2014 Email March 11, 2014 Meeting	January 31, 2014: NGTL invited Ed Barnett, Joann Skilnick and Grant Chapman to attend a meeting in Wandering River March 11, 2014 to discuss Project construction in caribou range. March 11, 2014: Meeting with Ed Barnett. NGTL stated that a discussion with AESRD Fish and Wildlife is necessary to discuss construction constraints and the possibility of constructing the compressor station during the caribou timing restriction.	5.1 5.6	Section 5.1 discusses the caribou timing window and NGTL's approach to "early in/early out" scheduling and additional mitigation to reduce the duration of activities that might extend past February 15. Section 5.6 provides the proposed construction and restoration schedule.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks ~~Sustainable Resource Development~~ (cont'd)				
Bill Black Acting Approvals Manager Athabasca, AB Ed Barnett Forest Officer Wandering River, AB	April 22, 2014 Email	NGTL experienced difficulties reaching the AESRD Wildlife Biologist in Fort McMurray, and requested AESRD's direction regarding project constraints (i.e., scheduling) with respect to constructing in the caribou range.	5.1 5.6	Section 5.1 discusses the caribou timing window and NGTL's approach to "early in/early out" scheduling and additional mitigation to reduce the duration of activities that might extend past February 15. Section 5.6 provides the proposed construction and restoration schedule.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB Ed Barnett Forest Officer Wandering River, AB Bill Black Acting Approvals Manager Athabasca, AB	May 4, 2014 June 19, 2014 July 16, 2014 Emails	May 4, 2014: AESRD (Joann Skilnick) recommended that the company develop a caribou habitat restoration plan, and encouraged coordination with restoration activities occurring on adjacent pipeline ROWs. June 19, 2014: NGTL requested whether construction of the compressor station can occur within the caribou timing window given that it is considered a permanent installation. July 16, 2014: NGTL inquired whether AESRD had had a chance to consider the information request from June 19, 2014.	1.2 5.1 5.6	NGTL will prepare Preliminary and Final CHRP in accordance with NEB Order. Construction and commissioning of the compressor station is planned to start outside the timing window for caribou (i.e., after July 15, 2015) but activities will extend to April 2016, which overlaps the timing window for caribou. Section 5.1 provides NGTL's approach to scheduling, and Section 5.6 provides the construction schedule.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	November 11 and 13, 2014 Email, Telephone	November 11, 2014: NGTL provided an update on the CMP schedule and requested a meeting to discuss. November 13, 2014: NGTL provided shapefiles and project fact sheet to Joann Skilnick and requested confirmation of meeting on November 28, 2014.	–	N/A

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks ~~Sustainable Resource Development~~ (cont'd)				
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	November 28, 2014 Meeting	NGTL provided an update of Project route, location and schedule. NGTL introduced the draft CMP to AESRD and discussed the differences between a CMP and a CHRP. AESRD recommended: • specifically linking mitigation to the desired outcomes listed in the EAP guidelines • demonstrating clearly how they link back, as opposed to the current EPP format used • including monitoring plans, monitoring to be effective – monitoring wolf densities or have wildlife cameras • avoiding use of following terms – "if practical," "if feasible" or "if possible" – identify when it will or won't be specifically • include information on helicopter protocols • include restoration AESRD requested in the CHRP that NGTL address access management plan. AESRD also advised that all areas have "facilitated" restoration unless evidence of where natural recovery is appropriate. Lastly for restoration, AESRD recommended that NGTL follow CEMA Restoration Guidelines (Stony Mountain Linear Restoration Project).	4 to 6	The CHRP incorporates the mitigation hierarchy (i.e., avoid, minimize, restore) to achieve CHRP goals and objectives (Section 2). Measures described in Section 4 to Section 6 reflect the mitigation hierarchy and are designed to achieve CHRP goals and objectives. EAP guidelines were considered in development of CHRP measures. Factors that constrain implementation are listed, where mitigation or restoration commitments include qualifiers such as "where site conditions allow." The CEMA Stony Mountain linear footprint and access management multi-stakeholder planning pilot project (Ohlson 2014) was reviewed during evelopment of the Preliminary CHRP. Intent of the project was to provide regional-scale recommendations amenable to a broad range of stakeholders, and inform design and implementation of future multi-stakeholder subregional planning processes undertaken as part of implementing the Lower Athabasca Regional Plan. The report provided high-level considerations and recommendations for planning multi-stakeholder restoration projects and managing linear features and access at the regional scale. The CHRP aligns with the applicable linear footprint and access management actions listed. The habitat and site-condition approach to selecting restoration methods and locations for the CHRP align with CEMA's suggested ecosystem-based revegetation matrix that was developed to support prioritization of linear features for treatment and evaluation of reclamation performance.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks ~~Sustainable Resource Development~~ (cont'd)				
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	January 7, 2015 Email	NGTL has considered AESRD's input and will complete a CHRP for the Project, which will supersede the CMP. As per AESRD's input, the construction start date at the proposed compressor station site has been altered to avoid the caribou timing restriction. The planned start date is now July 16, 2015. NGTL will use up to 8 m of temporary workspace over the existing pipeline ROW to reduce the Project footprint. The Project team is investigating opportunities to further reduce the permanent ROW. NGTL requested another meeting with J. Skilnick and E. Barnett.	4 5.1 5.6	Pre-construction planning considerations to reduce the Project footprint are discussed in Section 4. Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	January 30, 2015 Email	NGTL stated that the NEB issued an approval Order for the Project. Clearing and construction at the compressor station is scheduled from July 16, 2015 to April 1, 2016. Pipeline construction will start on September 1, 2015 as conditions allow and will continue into March 2015.	5.1 5.6	Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Ed Barnett Forest Officer Wandering River, AB	February 2, 2015 Email	AESRD stated that it is their expectation that the timing restriction in caribou range be adhered to. AESRD will not be in favour of providing extensions for construction activities into this timing restriction.	5.1 5.6	Timing windows and scheduling are discussed in Section 5.1 and Section 5.6.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and ParksSustainable Resource Development (cont'd)				
Ed Barnett Forest Officer Wandering River, AB	March 2, 2015 Meeting	NGTL provided a Project update indicating NEB approval and the caribou conditions (CHRP, OMP and CHROMMP) were discussed. NGTL provided recent details on the construction schedule. Use of timber for restoration measures was discussed and was confirmed as not being a concern. The applicability of the EAP guidelines to the Project and the ROW width were discussed.	5.1 5.6 4–6	Timing windows and scheduling are discussed in Sections 5.1 and Section 5.6. Pre-construction planning considerations to reduce the Project footprint are discussed in Section 4. Use of timber (coarse woody debris) is considered throughout the CHRP as a potential habitat restoration measure (particularly as it relates to rollback for access management).
Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB Grant Chapman Senior Wildlife Biologist Lac La Biche, AB	March 26, 2015 Meeting	AESRD indicated they will not have time to comment on the Preliminary CHRP until end of April. AESRD mentioned in previous CHRPs they were not invited to comment. NGTL stated this is a condition for Project approval.	3.5.2.2., Appendix A, 2, 6.2, 4.5.1	This Preliminary CHRP incorporates feedback from previous CHRPs, consultation and AESRD review of the CMP.
		AESRD recommended the option of transplanting trees, creating vegetation screens every 200 m, which provides immediate restoration in black spruce areas, line-of-sight control and restores connectivity.	3.5.4, 6.1, 6.2.5	Transplanting native vegetation is not a suitable CHRP measure since it has been shown to be a difficult technique to implement on a large scale, with marginal results and multiple limitations. In forested areas of the Project footprint where sight lines are 500 m long or more, line-of-sight blocks will be established.
		AESRD recommened minimum disturbance and boring techniques. NGTL mentioned that these activities increase duration of construction. AESRD stated that the timing restrictions should not be used as an excuse not to minimize more impacts.	6.1, 4.4, 4.5	Minimum disturbance construction is a suitable CHRP measure, and will be implemented where scheduling and soil conditions (i.e., frozen) allow. NGTL is considering extending the length of bored crossings to retain vegetation screens though logistical constraints (e.g., alternate access, technology capacity, pipe requirements) might inhibit implementation of this measure.
		AESRD requested that NGTL coordinate with Grand Rapids on caribou habitat restoration treatments.	–	NGTL states commitment to working with Grand Rapids and sharing information to facilitate this.

Table 7-1: Summary of Consultation Activities with Federal and Provincial Authorities Related to Caribou (cont'd)

Name and Title	Date and Method	Consultation Related to Caribou	Section in Preliminary CHRP	Comments and Rationale
Alberta Environment and Parks ~~Sustainable Resource Development~~ (cont'd)				
	March 26, 2015 Meeting (cont'd)	AESRD requested that NGTL talk to COSIA regarding provincial assessment of CHRPs/effectiveness published winter 2014/15. Offsets Management Plan: NGTL discussed the OMP condition from the NEB and asked if AESRD had any offset ideas. AESRD preference is for NGTL to restore habitat in the ESAR and on existing ROWs. AESRD would prefer NGTL spend money on minimizing and restoring, and then offsetting on own ROW or neighbouring ROWs. AESRD stated preference of 4:1 ratio.	3.5.2 1.2	Caribou habitat restoration initiatives, including COSIA, are described in Section 3.5.2 of the Preliminary CHRP. As per condition 7 outlined in NEB Order XG-N081-003-2015, NGTL will prepare a Preliminary and Final OMP, which will be filed under separate cover. The method used to calculate offset ratio will account for uncertainty and time lag.
	March 30, 2015 Email	NGTL provided AESRD with a Draft Preliminary CHRP for review and comment.	–	–
Joana Burgar Wildlife Biologist, on behalf of Joann Skilnick Senior Wildlife Biologist Fort McMurray, AB	June 17, 2015 Email	Ambiguous terms should be removed from the CHRP. Specify how mitigation measures criteria will be evaluated. EAP standards will be considered for this Project only if all EAP standards, guidelines and best management practices are considered, including Section 8: Wildlife, which states that in forested areas, line-of-sight should be limited to 200 m on non-roadway linear features. Until a detailed rationale for 500 m line-of-sight break is provided and deemed effective in mitigating impacts on caribou, target line-of-sight distance should be no greater than 200 m in forested segments. Provide rationale for natural revegetation vs active restoration. Concern about activity within the RAP and will not allow it if NGTL has not shown due diligence in completing work outside the RAP. AESRD plans status meetings with NGTL every two weeks during construction. Concerns about caribou mitigation measures during construction. AESRD recommended caribou monitoring project for duration of CHRP.	Throughout 5.1 5.4 6.3 5.2.1 Table 5-3 5.6 5.5	NGTL recognized this and has revised this CHRP to be more specific and clear in its approach. NGTL has provided rationale for the 500 m line-of-sight break. Active restoration (e.g., tree planting) will be promoted in areas where natural revegetation is not expected to achieve the quantifiable targets. NGTL is planning construction for outside the RAP and will update AESRD at biweekly meetings during construction. This section removed from the CHRP. NGTL will develop a Project CHROMMP that will span 15 years.

8.0 LITERATURE REVIEW

A literature review was conducted to provide regulatory and ecological context relevant to boreal caribou and specifically to the ESAR caribou range, including threats and management considerations for recovery of boreal caribou. This context provides an understanding of the current knowledge of the value and purpose of habitat restoration in caribou range.

In addition, available information on mitigation measures and habitat restoration methods was compiled and summarized in Section 5 and Appendix C. This summary was used to provide the foundation for the toolbox of measures available to NGTL to effectively mitigate potential Project effects on caribou and caribou habitat. Knowledge gaps that contribute to uncertainty in caribou habitat restoration are identified in Section 8.6. Based on the results of the literature review, the habitat restoration measures best suited for caribou range are identified.

8.1 LITERATURE REVIEW METHODS

The literature review incorporates regulatory and ecological context relevant to the ESAR caribou range to inform the selection of appropriate mitigation and habitat restoration measures. The key results from current boreal caribou literature as well as previous and ongoing habitat restoration initiatives, techniques implemented and their reported successes and failures were reviewed to inform the CHRP.

This methods section is provided to address Condition 6 of NEB Order XG-N081-003-2015. The literature review was completed using a systematic approach and standard research techniques, which enabled NGTL to consider the most recent published knowledge of caribou habitat restoration in the Preliminary CHRP. Sources reviewed include federal and provincial recovery strategies and management plans, previously submitted NGTL CHRPs, publically available government reports, in-house reference material and peer-reviewed journal articles. The literature review for the Preliminary CHRP included a systematic search of the following industry and scholarly databases for queried keywords and phrases:

- Google
- Google Scholar
- BioOne
- Web of Science
- Cumulative Environmental Management Association (CEMA) database, including Oil Sands Leadership Initiative (OSLI) historic filings

The following search terms were used in the literature review:

- caribou habitat restoration
- boreal caribou
- boreal forest and forested wetlands restoration
- linear corridor restoration/reclamation
- linear feature restoration in boreal forest and forested wetlands
- Alberta caribou recovery/range plan/policy/action plan

COSIA website (COSIA 2012) was searched to gather knowledge on current restoration measures, including the LiDea Project, the Algar Historic Restoration Project and OSLI environmental performance projects.

TERA, a CH2M Hill Company, attended the 15th North American Caribou Workshop (North American Caribou Workshop 2014), where several technical sessions related to habitat restoration for caribou were presented. Relevant information for CHRP planning related to use of rollback and monitoring wildlife use of restored linear features is summarized in the relevant sections of the literature review.

Caribou habitat restoration is receiving increasing research attention and it is anticipated that methods to restore habitat will continue to be tested and modified in the near future. NGTL will continue to incorporate this new information in the Final CHRP and post-construction monitoring.

8.2 REGULATORY POLICY, RECOVERY OBJECTIVES AND GUIDELINES FOR BOREAL CARIBOU

The Preliminary CHRP was developed considering current regulatory policies specific to boreal caribou. The identified regulatory policy and management documents considered to develop the Project CHRP include:

- *Alberta Woodland Caribou Recovery Plan, 2004/05 to 2013/14* (Alberta Woodland Caribou Recovery Team 2005)
- *A Woodland Caribou Policy for Alberta* (Government of Alberta 2011)
- federal *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*), *Boreal Population, in Canada* (Environment Canada 2012)

Further information on each of the documents listed above is summarized in the following paragraphs. NGTL began consultation and working collaboratively with provincial regulators, Aboriginal communities, stakeholders and industry partners in the early planning stages of the Project. NGTL will continue to work with provincial and federal regulators to align the CHRP measures with current provincial and federal policies.

The *Woodland Caribou Policy for Alberta* (Government of Alberta 2011) identifies recovery strategies that include maintenance and restoration of caribou habitat, establishment of range-specific habitat objectives, management of other wildlife populations (predators and primary prey), adaptive management, as well as legislative and social considerations. A key strategy adopted by the *Woodland Caribou Policy for Alberta* is the development of range-specific assessments and objectives (i.e., action plans), which builds on the work of previous recovery strategies, such as the *Alberta Woodland Caribou Recovery Plan 2004/05 – 2013/14* (Alberta Woodland Caribou Recovery Team 2005).

Similar to the provincial policy, the *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*)*, Boreal Population, in Canada* (Environment Canada 2012) stresses the importance of landscape-level planning, such as planning development activities at appropriate temporal and spatial scales, incorporating caribou habitat requirements in fire management plans, establishing key protected areas and incorporating adaptive management. One of the management approaches suggested in the federal recovery strategy to address effects of habitat alteration on boreal caribou is to undertake coordinated actions to reclaim boreal caribou habitat through restoration efforts. This might include restoration of industrial features such as roads, seismic lines, pipelines, cut lines and clearings (Environment Canada 2012). The Preliminary CHRP adopts the definition of caribou habitat provided in the Recovery Strategy (i.e., habitat in defined caribou ranges that is necessary to maintain or recover self-sustaining local populations throughout their distribution).

NGTL is continuing to work with AESRD to align the CHRP measures with the provincial caribou policy and the future provincial Caribou Action Plan for the ESAR caribou range. Range-specific Caribou Action Plans are required as part of the province’s commitment to the proposed federal Recovery Strategy. A range-specific assessment or recovery plan for the ESAR caribou range has not yet been developed by the province.

The goal of the *Recovery Strategy for the Woodland Caribou* (*Rangifer tarandus caribou*)*, Boreal Population, in Canada* is to achieve self-sustaining local populations in all boreal caribou ranges throughout their current distribution in Canada, to the extent possible (Environment Canada 2012). The Recovery Strategy applies to the ESAR caribou range. Population and distribution objectives identified in the Recovery Strategy include, to the extent possible:

- maintain current status of the 14 existing self-sustaining local populations
- stabilize and achieve self-sustaining status for the 37 non-self-sustaining local populations (a group that includes the ESAR caribou range)

The federal Recovery Strategy identifies critical habitat for the boreal woodland caribou as:

- the area within the boundary of each caribou range that provides an overall ecological condition that will allow for an ongoing recruitment and retirement cycle of habitat, which maintains a minimum of 65% of the area as undisturbed habitat
- biophysical attributes required by boreal caribou to carry out life processes (Environment Canada 2012)

Therefore, the habitat threshold that provides a measureable probability for a local caribou population to be self-sustaining is considered to be 65% undisturbed habitat in the range (Environment Canada 2012).

In addition to the recovery planning and policy documents described above, NGTL considered the *Integrated Standards and Guidelines – Enhanced Approval Process* (Alberta Energy Regulator [AER] 2013) to develop caribou-specific mitigation measures. These standards and guidelines identify desired outcomes, which include:

- reduction of human-caused direct mortality associated with linear features
- excessive predator-caused mortality
- habitat loss
- partial avoidance demonstrated by caribou in relation to industrial features
- increases in distribution and productivity of other prey species

Approval standards are specified, as are best management practices.

8.3 BOREAL WOODLAND CARIBOU ECOLOGY

As previously mentioned, the boreal population of woodland caribou is listed as Threatened on Schedule 1 of *SARA*, by COSEWIC and under the Alberta *Wildlife Act* (AESRD 2014a; COSEWIC 2015; Environment Canada 2015).

Woodland caribou in Alberta are found in bogs and fens with low to moderate tree cover and tend to avoid marshes, uplands, heavily forested wetlands, water and areas of human use (Thomas and Gray 2002). Local caribou population ranges encompass areas large enough for all life processes (calving, rutting, wintering). Therefore, woodland caribou require large tracts of continuous undisturbed habitat, as they disperse when calving to reduce predation risk (Vistnes and Nellemann 2001; Environment Canada 2011). Preferred habitat is typically mature coniferous forest (e.g., jackpine and black spruce) with abundant lichen, muskeg and peatlands intermixed with upland or hilly areas (Brown, Huot et al. 1986; Bradshaw et al. 1995; Stuart-Smith et al. 1997; Neufeld 2006; O’Brien et al. 2006; Brown, Rettie et al. 2007; Rettie and Messier 2000; Courtois and Ouellet 2007).

Sufficient canopy cover or wind-exposed areas are required to keep snow depth at low enough levels to allow foraging (LaPerriere and Lent 1977; Collins and Smith 1991; Schaefer and Pruitt 1991).

Boreal woodland caribou do not undergo seasonal migrations and remain in forest and peat habitats throughout the year (Alberta Woodland Caribou Recovery Team 2005). Forested peat complexes are the primary habitat for boreal caribou and they require large contiguous tracts of this preferred habitat to maintain low population densities across their range as an anti-predator tactic (Alberta Woodland Caribou Recovery Team 2005). Boreal caribou maintain spatial separation from other ungulates by occupying habitat that has a lower density of other ungulate species (Alberta Sustainable Resource Development [ASRD] and Alberta Conservation Association [ACA] 2010).

The rutting season occurs in early to mid-October, and caribou have a gestation period of approximately 7.5 to 8 months. In northern Alberta, most calves are born in the first two weeks of May (ASRD and ACA 2010).

Compared with other forest-dwelling ungulate species, woodland caribou exhibit low reproductive potential. Adult cows are typically three years old before they begin producing young and only produce a single calf annually (ASRD and ACA 2010).

The ESAR caribou range is located east of the Athabasca River, and includes seven small populations of caribou that are largely independent from each other: Algar, Egg–Pony, Agnes, Wandering, Wiau, Bohn and Christina (ASRD and ACA 2010). Radio-telemetry data indicate that very little movement occurs between caribou ranges (ASRD and ACA 2010). The Project is located in the Egg-Pony and Algar ranges.

Estimated caribou population size in the ESAR caribou range is 90 to 150 individuals and the population trend is declining (Environment Canada 2012). The ESAR caribou range is 1,315,980 ha in area (Environment Canada 2012). The population growth for the ESAR caribou range was 0.81 in 2007/2008, with calf recruitment between 12.6 and 16.1 calves per 100 cows. A total of 116 caribou were observed in the ESAR caribou range during the 2008 caribou/calf surveys. The population of the ESAR caribou range was stable to declining between 1992/1993 and 1999/2000, but has consistently declined since (Athabasca Landscape Team 2009). Environment Canada (2012) reports that 81% of the ESAR caribou range is affected by anthropogenic and fire disturbance, which exceeds the threshold level of disturbance (35%) that will support a self-sustaining caribou population.

8.4 THREATS AND LIMITING FACTORS

Threats to boreal woodland caribou identified by the federal Recovery Strategy (Environment Canada 2012), in descending order of direct impact on caribou population trend, are:

- predation
- habitat alteration from human land-use activities
- natural disturbance of habitat
- hunting
- climate change and severe weather

Other threats considered to have a lower level of concern include parasites and disease, stress responses associated with sensory disturbance (noise and light), vehicle collisions and pollution.

Available literature supports apparent competition as the likely causal pathway for woodland caribou population declines, whereby primary prey species (e.g., moose, deer) increase with increasing proportions of early seral habitat on the landscape, causing a numerical response of predators (COSEWIC 2002; Environment Canada 2012; Latham 2009; Seip and Cichowski 1996; Wittmer et al. 2005). Wolves are considered the primary predators of caribou across northern Canada and predation by wolves was implicated as the most common cause of death for adult caribou in northeastern Alberta (McLoughlin et al. 2003). Black bear can also be a common predator of caribou (Rettie and Messier 1998; Zager and Beechman 2006).

Increases in predator numbers subject caribou to unsustainable levels of predation, causing population decline (Wittmer et al. 2005). Predator densities capable of causing caribou declines are usually sustained by abundant alternate prey sources, such as moose or white-tailed deer (COSEWIC 2002; Peters et al. 2013; Wittmer et al. 2005). Predation on caribou is thought to be largely incidental, given the low densities of woodland caribou compared with much more abundant prey species (Wittmer et al. 2005).

The primary selection of peatlands and old-growth forest by caribou, and lack of positive habitat selection non-use of these areas by moose, wolves (Rettie and Messier 2000) and black bears (Latham et al. 2011) was determined to result in spatial separation (James et al. 2004). This strategy is believed to be used to combat the widespread influence that wolves have in an ecosystem (Ripple and Beschta 2004; Ripple et al. 2014). Removal or alteration of habitat (e.g., forest harvesting [McCutchen 2007]) will dissolve what spatially separates caribou and primary prey (i.e., moose). Following forest harvest, moose and woodland caribou were more likely to use the same habitat, and woodland caribou suffered higher rates of wolf predation (Peters et al. 2013).

The influence of anthropogenic linear feature density on predation rates might be equally as important to caribou mortality as the density of predators (Whittington et al. 2011). The ultimate cost to caribou habitat suitability appears lower for linear feature-induced changes compared with forestry-induced (i.e., cutblocks) changes (DeCesare et al. 2012). Linear feature-induced changes have been previously linked to changes in predator functional response (predator kill rate) while forestry-induced changes have been previously linked to changes in predator numerical response (predator density).

Evidence shows scale-dependent variation in caribou resource selection, where habitat selection at the population and individual seasonal home range scale is affected by forestry cutblocks (DeCesare et al. 2012). Forestry cutblocks are linked to increased predator densities (Latham et al. 2011). Conversely, caribou distribution is shown to be strongly influenced by linear disturbance at the finer (location-level) scale (DeCesare et al. 2012).

Linear corridors provide improved access for predators such as wolves. Several studies have found that linear corridors are attractive to bears (McKay et al. 2014) and especially wolves as easy travel routes (James 1999; James and Stuart-Smith 2000; Stuart-Smith et al. 1997; Thurber et al. 1994; Whittington et al. 2011). As a result, linear disturbances can influence predator/prey dynamics (Bergerud et al. 1984; Edmonds and Bloomfield 1984; Rohner and Kuzyk 2000). Wolves travel faster along linear disturbances (James 1999; McKenzie et al. 2012) and encounter rates between wolves and caribou have been shown to increase near linear features (Whittington et al. 2011).

Furthermore, it is suggested that while wolves increase movement rates on linear disturbance features, their movement rates decrease in proximity to disturbance features. This implies behaviour closely associated with prey searching and hunting (Ehlers et al. 2014). However, modelling the dynamic use of the landscape by wolves, primary prey (moose) and caribou showed that wolves experience no additional advantage accessing caribou from linear features, although they do benefit in accessing primary prey species (McCutchen 2007). This is supported by a study that found that kill sites were no closer to linear features than random (Latham et al. 2011).

Caribou are sensitive to anthropogenic disturbance (e.g., industrial activity [Dyer et al. 2001, 2002]) and habitat alteration (e.g., forestry [Peters et al. 2013]), and to natural disturbance (e.g., burns [Schaefer and Pruitt 1991]). Long-term reduction in habitat effectiveness adjacent to linear features can occur as caribou have been shown to partially avoid habitats near ROWs (Dyer 1999; Oberg 2001). Avoidance of habitat near anthropogenic disturbances leads to indirect habitat loss through reduced habitat effectiveness for caribou (Dyer et al. 2001).

Methods and study populations vary among research studies that demonstrate caribou avoidance of disturbances by varying distances: 70 m (seismic lines and maintained trails [DeCesare et al. 2012]), 250 m (roads and seismic lines [Dyer et al. 2001]) and 1,000 m (industrial developments such as well sites [Dyer et al. 2001]). The federal Recovery Strategy for boreal caribou defines disturbance of critical habitat as the area affected by human-caused disturbance, including a 500 m buffer around the disturbance to account for avoidance by caribou, and the area affected by fire less than 40 years old (Environment Canada 2012).

Restoration of disturbance assumes that caribou will return to being spatially separated from primary prey (moose, deer) and predators, and hence natural levels of mortality risk (Athabasca Landscape Team 2009). Management of boreal caribou habitat to maintain viable populations over time will require both minimizing the impact of future development and recovery of the existing industrial footprint.

Woodland caribou populations are very low in many areas and, therefore, populations simply might not rebound due to increasing rates of inbreeding and other, well-defined detrimental effects of genetic drift that are characteristic of small, genetically isolated populations (Bijlsma et al. 2000; Frankham 2005; Hedrick and Kalinowski 2000; Keller and Waller 2002). This phenomenon, known as the Allee effect, was recently suggested to likely occur in the boreal population of woodland caribou in Alberta (Hervieux et al. 2013; Serrouya et al. 2012).

8.5 CARIBOU RECOVERY AND HABITAT RESTORATION

The lowland habitat types naturally have very slow rates of vegetation establishment and growth, making tree seedling establishment and growth in a 15-year period unpredictable. Guidelines for wetland restoration associated with oil sands mining (AENV 2008) focus on disturbance types that are not applicable to pipeline construction and operation. Furthermore, reclamation of bogs and fens (i.e., the treed lowland and shrubby/graminoid lowland habitat types addressed in this CHRP), is in experimental stages and is not addressed in the current guidelines. The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* includes specifications for various indicators using an “end land use” approach that targets reclamation to commercial forests, which conceptually provide other ecosystem functions including wildlife habitat (AENV 2010).The application of these guidelines to the CHRP needs to be approached with caution, since they relate to a very different disturbance type (i.e., bitumen mining vs. pipeline ROW) and are developed for different objectives.

With these limitations in mind, it is recognized that the AENV guidelines for oil sands reclamation are developed for boreal forests with similar attributes to those on the Project and, therefore, some of the thresholds and indicators were used to guide the development of quantifiable targets for the CHRP.

In particular, the quantifiable targets associated with treed lowland and shrubby/graminoid lowland habitat types incorporated the concept of plant community composition as an appropriate indicator to assess reclamation status and progress (AENV 2010). This is supported by the suggestion that the number and abundance of characteristic species (i.e., species typically found in undisturbed native wetland plant communities) and the number of restricted weeds are measures for plant community health (Cibrowski et al. 2012).

Plant community composition as described in the *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* (AENV 2010) and characteristics of healthy plant communities in treed lowlands were used to develop quantifiable targets for the lowland habitat types in this CHRP. A threshold of two characteristic species in wet poor sites is suggested, which was derived to be conservative (low) with respect to realistic achievement of thresholds (AENV 2010). This species threshold was determined based on data from reclaimed oil sands 20 or more years after reclamation (AENV 2010). Given the much lower disturbance level associated with pipeline construction and operation compared with oil sands mining, three characteristic species within the 15-year monitoring period is likely a reasonable quantifiable target and has been adopted for restoration of the lowland habitat types in the Preliminary CHRP (see Table 4-1). Characteristic species can include vascular and non-vascular plants, provided they are species found in the adjacent undisturbed native plant community. The other quantifiable targets for lowland habitats are absence of restricted weeds to indicate vegetation community health and 80% vegetation cover by characteristic species. Quantifiable targets are also provided in Table 4-1 for lowlands where conifer seedlings are planted in mounded sites.

There are no existing specifications for design and implementation of caribou habitat restoration measures. As a result, restoration criteria and guidelines for forested areas in Alberta and reforestation standards in Alberta specific to the Project area (Alberta Environment [AENV] 2001, 2008, 2010; AESRD 2013b,c, 2014b) were used to develop appropriate specifications for the CHRP restoration measures.

A common approach in reclamation of forested land in Alberta is the application of provincial standards developed to achieve equivalent land capability to support target end land uses, often with a focus on merchantable forest stands (e.g., AENV 2010; AESRD 2013b). In relation to oil sands mining in northeastern Alberta, Straker and Donald (2011) and Hawkes (2011) have suggested that current reclamation standards might not be suitable where there is a broader set of management objectives such as maintenance of biodiversity, creating functional forest ecosystems or restoration of species-specific wildlife habitat.

The Reclamation Assessment Criteria for Pipelines (AENV 2001) recommends that equivalent land capability should take into account natural variability, which considers the range of landscape attributes that are encountered and influenced by slope, drainage, coarse fragments, vegetation growth and composition, and soil color, texture, aggregate strength and size.

The *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases* (AENV 2008) focuses on disturbance types that are not applicable to pipeline construction and operation. Furthermore, reclamation of bogs and fens (i.e., the treed lowland and shrubby/graminoid lowland habitat types addressed in this CHRP), is in experimental stages and is not addressed in the current guidelines.

The *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands* (AESRD 2013b) provides reclamation criteria that apply to well site leases and access roads, and associated facilities such as pits, campsites and offsite sumps. Criteria are provided to determine whether a reclaimed site meets equivalent land capability, based on function and operability of the land to support the production of goods and services consistent in quality and quantity with the surrounding landscape. A minimum 25% cover of herbaceous and of woody species is recommended for naturally regenerating and planted sites in forested lands. The document suggests that ecosystem function can be determined when natural processes are evident, such as proper drainage, moisture retention and cycling, soil and site stability, and nutrient cycling (i.e., litter formation). Recommendations for assessing reclamation success are provided for various factors such as drainage, erosion, soil stability, woody debris, plant community composition and cover, litter and LFH development, and soil characteristics.

The *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region* includes specifications for various indicators using an "end land use" approach that targets reclamation to commercial forests (AENV 2010). In concept, commercial forests also provide other ecosystem functions. The application of these guidelines to the CHRP needs to be approached with caution, since they relate to a very different disturbance type (i.e., bitumen mining vs. pipeline ROW) and are developed for different objectives. The *Alberta Regeneration Standards for the Mineable Oil Sands* (AESRD 2013c) are similarly applicable to reforestation of oil sands mines. The standards outline protocols for establishment and performance surveys to determine reforestation establishment and continued growth, where commercial forestry is the end land use. Seedling planting or target densities are not specified. The standard does, however, provide guidance on determining "poorly revegetated areas" based on the size (≥0.5 ha) and proportion (≥25%) of trees affected by mortality, foliage loss/discolouration, missing or low density, physical damage, or poor form or vigour.

The *Reforestation Standard of Alberta* (AESRD 2014b) specifies that openings (i.e., cutblocks) are considered sufficiently regenerated if 80% or more of area contains acceptable tree regeneration. Regeneration is assessed by tree characteristics including species composition and density, spatial distribution, height, well-defined stems and damage. The standards are intended for reforestation of commercially harvested forests, with the intent of regenerating commercially viable forests.

8.6 VEGETATION REESTABLISHMENT

Restoration of disturbed habitat has become one of the key components for caribou conservation identified through the federal Recovery Strategy (Environment Canada 2012) and in provincial boreal caribou recover planning (Alberta Woodland Caribou Recovery Team 2005; Government of Alberta 2011). This section summarizes information from habitat restoration guidelines, previous caribou habitat restoration initiatives, and published research. Information on restoration methods employed and effectiveness or success of restoration is included. This section is supplemented with information specific to restoration initiatives already completed in boreal woodland caribou range (see Appendix C), which was considered as context in Preliminary CHRP development.

8.6.1 Tree Planting and Natural Regeneration

Recent research has shown positive results for establishing native vegetation on seismic lines and other linear features using techniques such as planting tree and shrub seedlings, and site preparation to create microsite conditions (i.e., tree planting methods) that are conducive to both planted seedling growth and natural vegetation encroachment (CRRP 2007b; COSIA 2012). Measures such as rollback can address site condition issues, including competition from non-target or undesired plant species, erosion, frost, and heat or moisture deficiencies (CRRP 2007b). These methods are consistent with the approach adopted by NGTL in previous CHRPs.

Natural revegetation and successful planting initiatives benefit from construction practices that minimize disturbance during development of the footprint. Minimum disurbance pipeline construction techniques that avoid grubbing and grading are effective at facilitating rapid regeneration of native vegetation in the ROW, in particular in areas with a deciduous vegetation component (TERA 2011a,b, 2012). Implementation of minimum disturbance construction can be limited by such factors as terrain that requires grading, ground conditions (e.g., non-frozen soils) and construction methods (e.g., crossings of third-party dispositions).

A trial natural revegetation response inventory program in west-central Alberta reported that 85% of disturbed sites did not require artificial recovery, since a natural recovery projection was observed on previously disturbed sites (CRRP 2007c).

Although regenerating conifers provide a better visual barrier, the faster growth rates of deciduous species provides for effective results more quickly (Diversified Environmental Services [DES] 2004). Recent research suggests that planting shrubs along with trees allows trees to grow healthier, faster and with less competition for nutrients and water from fast-growing grasses (COSIA 2012). It might also provide important habitat benefits for wildlife, compared with only planting tree seedlings, by providing hiding cover (Bayne et al. 2011).

Conventional seismic lines have been reported to have very slow reforestation rates (Revel et al. 1984; Osko and MacFarlane 2000), and recovery is strongly influenced by the characteristics of the adjacent forests (e.g., site productivity, tree and shrub species and heights) (Bayne et al. 2011). Conventional seismic lines cleared by bulldozer can take as long as 112 years to reach 95% recovery to woody vegetation in the absence of restoration efforts (Lee and Boutin 2006). Slow tree regeneration has been attributed to root damage from the original disturbance, compaction of the soil in tire ruts, insufficient light reaching the forest floor, maintenance of apical dominance from surrounding stands, introduction of competitive species (i.e., planted seed mixes), site drainage (i.e., regeneration slowest on poorly drained sites with low nutrient availability such as bogs) and repeated disturbances (e.g., all-terrain vehicles [ATVs], animal browsing, repeated exploration) on seismic lines (Revel et al. 1984; MacFarlane 1999, 2003; Sherrington 2003; Lee and Boutin 2006). However, tree regeneration on seismic lines is a key determinant of recovery success (MacFarlane 2003) and, therefore, factors that hinder revegetation efforts should be mitigated. Although seismic lines and pipeline ROWs are both linear disturbances, drawing parallels between regeneration success on these different features should be done with caution. Restoration issues on seismic lines might not be comparable to pipeline ROWs, given differences in disturbance mechanisms, degree of soil and vegetation disturbance, reclamation practices and width of the features (i.e., the wider openings of ROWs allow more light and insolation than narrow seismic lines, which might facilitate better vegetation regrowth).

Evidence presented at the 15th North American Caribou Workshop demonstrated winter tree planting and mechanically bending live trees into the ROW are emerging mitigation options that are currently being implemented in the Alberta oil sands region (North American Caribou Workshop 2014). Tree bending might be particularly promising as it promotes natural revegetation by increasing cone deposition onto the disturbance footprint and creating microsites through shading and dropped dead woody debris. However, these mitigation measures are only initially being evaluated and their utility remains unknown. Furthermore, they were applied on seismic lines that are substantially narrower than pipeline ROWs and do not require continued operation activities, as do pipelines.

8.6.2 Transplanting and Seeding

Transplanting native vegetation appears to be difficult to implement on a large scale as part of a habitat restoration program for the following reasons (Golder 2012a):

- inconsistent availability of vegetation suitable for transplant
- potential for degradation of neighbouring vegetation communities if transplants are sourced from adjacent stands
- transplanting programs often result in the storage of plant materials under less-than-ideal conditions due to uncontrollable factors (i.e., weather)
- other treatments, such as seeding and seedling planting, have been shown to be more successful in comparison

An alternative to salvage and transplanting vegetation is to seed disturbed areas using seed collected from the same geographic region as the restoration project. Broadcasting seed either aerially or using ground methods (by hand or mechanically) is also an option. However, since pipeline ROWs are relatively narrow openings (compared with cutblocks, for example), sufficient natural seed ingress from the adjacent undisturbed habitat can facilitate natural recovery without additional seed application. Logistically, the feasibility of seeding can be constrained where the reclamation project is a substantial distance from an airport or airfield (i.e., for aerial seeding), or where ground access during non-frozen conditions is restricted by wet soils. Furthermore, direct seeding of conifers is not a preferred reforestation technique, partly due to problems with seed predation (British Columbia Ministry of Forests 1997).

8.7 EFFECTS OF HUMAN USE ON RESTORATION

The ability of linear features to recover to a natural forested state is affected considerably by human use. Recovery of conventional seismic lines to functioning mountain caribou habitat occurs was identified to be within 20 years following disturbance in west-central Alberta (Oberg 2001).

Seismic lines in the Little Smoky caribou range that were allowed to revegetate naturally reportedly achieved an average height of 2 m across all ecosite types, within 20 to 25 years, when they had not been recently disturbed by human activity (e.g., re-cleared to ground level for winter access or seismic program use [Golder 2009]). The average age of trees on the control lines was only 10 years, suggesting sites that are continually disturbed or re-cleared by human activity take longer to regenerate.

Restoration efforts have also failed when ATVs destroyed seedlings after planting (Enbridge 2010; Golder 2011, 2012b). Evidence of the effects of repeated motorized access on vegetation establishment and regrowth supports the use of access management tools to enhance restoration success.

Subjective expert ratings suggest that the effectiveness of most physical access management measures (e.g., berms, excavations, rollback, visual screening) varies considerably between negligible and high effectiveness in managing human access (Golder 2007). Effectiveness of access management measures likely depends on suitable placement (e.g., placed to prevent detouring around an access management point), enforcement and public education of the intent of the access management (AXYS Environmental Consulting Ltd. [AXYS] 1995). Public education (e.g., signs) facilitates respect for the purpose of, and compliance with, access management measures.

Mounding has been found to discourage human access (i.e., truck and ATV) during snow-free periods and also creates microsites that improve vegetation establishment (review in Golder 2007). Excavator mounding is a well-researched and popular site preparation technique in the silviculture industry (Macadam and Bedford 1998; Roy et al. 1999; MacIsaac et al. 2004). Target density of mounding for access management and/or microsite creation purposes can vary from 1,400 to 2,000 mounds/ha (AENV 2010; Golder 2012a). However, these mound densities relate to restoring seismic lines that were not frozen-in to allow heavy equipment access. Given the challenges of the wet conditions and frost requirements for accessing the Project footprint (i.e., freezing-in the peat for access can make it difficult to excavate small mounds), the size of mounds could potentially be substantially larger than mounds achieved on previous seismic line restoration projects. Furthermore, mounds cannot be excavated within 5 m of the operating pipeline, which reduces the mound density relative to disturbances that do not have similar restrictions. As a result, the mound density that can realistically be achieved in pipeline ROWs is lower.

Human access on open and closed (i.e., gated, barriered and recontoured) roads was monitored using remote cameras (Switalski and Nelson 2011). That study found that the frequency of detection of humans on closed roads was significantly lower than on open roads, but not significantly different among road closure types. The monitoring results also indicated significantly higher levels of hiding cover and lower line-of-sight distances on barriered and recontoured roads compared with open roads (Switalski and Nelson 2011). A similar study investigated the effectiveness of different approaches (i.e., year-round closure, seasonal closure, deactivation, and deactivation and closure) at limiting motorized vehicle traffic on unpaved roads designed to support forestry operations (i.e., resource roads) (Hunt and Hupf 2014).

Results demonstrated that closure and/or deactivation approaches significantly reduced traffic on resource roads (about 78%), with year-round closure being the least effective while seasonal (i.e., hunting) closure being among the most effective approach (Hunt and Hupf 2014). The effectiveness of different approaches did not depend on road quality (Hunt and Hupf 2014). Physical access management measures provide short-term solutions to manage access and allow for natural regeneration (Golder 2009). Once linear features have regenerated to a pole sapling or young forest structural stage, they no longer facilitate ATV access (Sherrington 2003).

The techniques described above to block human access also contribute to achieving sufficient revegetation to block line–of–sight. Short-term management for access and line-of-sight blocking should ultimately lead to long-term access management by way of revegetation of disturbed areas (Golder 2007). Expediting growth of visual barriers along linear features can be achieved by concentrating restoration efforts on productive upland habitats, since woody vegetation species grow more quickly on these sites compared with lowland sites. Although regeneration of conifer species provides the best year-round visual barrier, their growth can be slow. Using combined plantings of conifer and fast-growing deciduous woody species in small areas (e.g., narrow strips of plantings across the ROW) can establish visual barriers in the short to medium term, while maintaining the objective of regenerating conifer-leading vegetation in the long term.

Coarse woody material (rollback) can be effective to manage human access as well as to conserve soil moisture, moderate soil temperatures, provide nutrients as debris decomposes, limit soil erosion, provide microsites for seed germination and protection for introduced tree seedlings (Pyper and Vinge 2012; Vinge and Pyper 2012). Rollback is effective immediately following implementation, provided adequate material is available and properly applied. Debris should be spread evenly across the entire footprint width at a coverage/density that will not restrict ability to plant seedlings or limit planted or natural seedling growth. Where sufficient material is available, the suggested woody debris coverage at selected locations is 60-100 m^3/ha on upland sites and 25-50 m^3/ha on lowland sites, to mimic natural processes (Pyper and Vinge 2012; Vinge and Pyper 2012). Where sufficient material is available, woody debris coverage of 150-200 m^3/ha along ROWs can be used to manage human and wildlife access (Vinge and Pyper 2012). The storage and placement of woody debris must consider reducing ladder fuels to reduce fire hazard (Pyper and Vinge 2012). Short segments (i.e., <100 m) of rollback might be less effective at deterring human access because ATV and snowmobile riders might try to ride through the debris or traverse around it in adjacent forest stands (Vinge and Pyper 2012). Complete rollback (i.e., over an entire linear disturbance) could be used to prevent motorized access (Pyper and Vinge 2012), however, availability of material is a limiting factor. The *Integrated Standards and Guidelines for the Enhanced Approval Process* recommend a 25 m rollback-free fuel break be placed every 250 m along segments of rollback (AER 2013).

8.8 WILDLIFE USE OF REGENERATING LINEAR DISTURBANCE

While there has been some effort to assess wildlife use of regenerating seismic lines (e.g., Bayne et al. 2011) and reclaimed areas in the Athabasca oil sands region (e.g., Hawkes 2011), few researchers have assessed natural habitat recovery and wildlife responses to recovery with respect to caribou. A pilot study in the Little Smoky caribou range measured effects of revegetating linear disturbances on wildlife use and mobility (Golder 2009). Data were collected for a group of predators (i.e., cougar, wolf, coyote, lynx, grizzly and black bears) and prey (i.e., moose, deer and caribou). Results of the pilot study indicated that revegetated seismic lines (i.e., minimum 1.5 m vegetation regrowth) were preferred by both predator and prey species compared with control lines (i.e., vegetation regrowth of 0.5 m or less), and control lines were used primarily for travel (i.e., both predators and prey species were constantly moving as opposed to standing or foraging).

In addition, human use was almost exclusively limited to the control lines. The line-of-sight measured on the revegetating lines was typically less than 50 m long. It was suggested that moose and deer might have been attracted to the revegetated lines for forage availability and perceived cover protection (Golder 2009). The preference for regenerating seismic lines by wolves can be explained as a response to increased prey use of these lines (Golder 2009). The study also showed that caribou travelled more quickly (running more frequently) and did not engage in standing-related behaviour on control lines, whereas on revegetating lines, running was rare and standing-related behaviour occurred more often.

Another ongoing project in northern Alberta involving the Cold Lake caribou herd is currently investigating the responses of predator and prey species to the deactivation or restoration of habitat disturbance features (McNay et al. 2014). The goal of the project is to determine how different species (wolves, bears, moose and caribou) use the landscape, and how the presence or absence of linear disturbances might influence the functional and numerical response of predators (McNay et al. 2014). The project is still in the early stages. Preliminary results suggest that among all species seasonal and annual movements are variable, with substantial overlap between the range extents of all four species. Additionally in these range overlaps, were 19 instances where predator and prey could have encountered one another. Furthermore, preliminary results present 11 deaths of 94 collared animals: 2 caribou, 3 moose, 1 bear and 5 wolves. Predator kill sites identified included 143 bear sites and 93 wolf sites. These kill sites were implicated in the deaths of 11 caribou, 22 moose and 6 deer. Ongoing data collection and processing will provide future results from scat analysis, prey body condition, habitat modelling and mapping.

The project aims to address several management questions regarding the desired vegetative and spatial characteristics on the landscape to reduce caribou mortality, how silvicultural techniques and mitigation measures can be implemented to achieve these characteristics, the association between specific characteristics and predator efficiency and/or density, and when deactivated linear features can be considered to have lost their disturbance function (McNay et al. 2014). This project is associated with the RICC initiative.

Mechanically bending or felling live trees over a linear disturbance (often referred to as line-blocking, particularly when used in conjunction with other treatments such as mounding) is another potential measure that might have benefits for managing access and reducing wolf use. Trees are typically bent or felled from both sides of the linear disturbance. Tree felling entails cutting trees at the base from the edge of the linear disturbance, and allowing them to fall across the linear disturbance.

Tree bending requires mechanically bending from the base of the tree, partially exposing roots, so that the tree leans over the linear feature, close to the ground. Tree bending can be expensive and the process is time consuming. A preliminary assessment of tree felling along seismic lines to block access was completed in the Little Smoky herd range in Alberta during summer and fall 2004 (Neufeld 2006). While results of that study showed no statistical significance between wolf use of blocked versus non-blocked seismic lines, there was an indication that wolves tended to use areas with unblocked seismic lines more often than areas with blocked seismic lines (Neufeld 2006).

Based on these results, it was concluded that if tree felling is to be used as a line-blocking measure, it should be investigated more thoroughly, and not relied on solely as a mitigation tool (Neufeld 2006). Preferably, line-blocking should be used with other management actions such as habitat restoration (Neufeld 2006), and continue to be evaluated for effectiveness using an adaptive management approach. As previously described, tree felling or bending is often completed in conjunction with other measures, such as mounding, spreading coarse woody debris or seedling planting to achieve line-blocking.

As presented at the 15th North American Caribou Workshop, preliminary results of linear feature blocking programs suggest that this type of mitigation can be effective in reducing wildlife use of linear features (North American Caribou Workshop 2014).

8.9 KNOWLEDGE GAPS AND LIMITATIONS OF THE LITERATURE REVIEW

The literature review provided the opportunity to identify the following knowledge gaps:

- restoration criteria (e.g., defined guidelines or quantifiable objectives) for restoration of boreal ecosystems for wildlife habitat values, in particular habitats that do not support merchantable timber (e.g., treed bogs and fens)
- functional responses of caribou, wolves and primary prey (e.g., moose, deer) to reclaimed habitats in various stages of successional progression, as well as to access and line-of-sight management
- long-term monitoring of vegetation recovery on linear disturbances and of predator response to access management measures

9.0 REFERENCES

9.1 TEXT REFERENCES

Alberta Energy Regulator. 2013. *Integrated Standards and Guidelines*. Enhanced Approval Process (EAP). Effective: December1, 2013. Edmonton, AB. 94 pp.

Alberta Environment and Sustainable Resource Development. 2012. *Caribou Protection Plan Guidelines and Caribou Calving Information*. Edmonton, AB. 3 pp.

Alberta Environment and Sustainable Resource Development. 2013a. *Caribou Protection Plan (CPP) Submission Requirements for Winter 2013/14*. Industry Bulletin. October 2013. Edmonton, AB. 2 pp.

Alberta Environment and Sustainable Resource Development. 2013b. 2010 *Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands (Updated July 2013)*. Edmonton, AB. 81 pp.

Alberta Environment and Sustainable Resource Development. 2013c. *Alberta Regeneration Standards for the Mineable Oil Sands*. Government of Alberta, Department of Environment and Sustainable Resource Development. Edmonton, AB. 71 pp.

Alberta Environment and Sustainable Resource Development. 2013d. *Alberta Wildlife Animal Care Committee Class Protocol 013*. July 2013. Edmonton, AB. 3 pp.

Alberta Environment and Sustainable Resource Development. 2014. *Species Assessed by Alberta's Endangered Species Conservation Committee*. Updated July 4, 2014. Fish and Wildlife Policy Branch. Edmonton, AB. 2 pp.

Alberta Environment and Sustainable Resource Development. 2014b. *Reforestation Standard of Alberta*. Government of Alberta, Department of Environment and Sustainable Resource Development. Edmonton, AB. 264 pp.

Alberta Environment. 2001. *Reclamation Assessment Criteria for Pipelines – 2001 Draft*. Edmonton, AB. 70 pp. + Appendices.

Alberta Environment. 2008. *Guideline for Wetland Establishment on Reclaimed Oil Sands Leases, 2nd Edition*. Prepared by M.L. Harris of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, AB. 103 pp. + Appendices.

Alberta Environment. 2010. *Guidelines for Reclamation to Forest Vegetation in the Athabasca Oil Sands Region, 2nd Edition*. Prepared by the Terrestrial Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. Fort McMurray, AB. 332 pp.

Alberta Sustainable Resource Development and Alberta Conservation Association. 2010. *Status of the Woodland Caribou (*Rangifer tarandus caribou*) in Alberta: Update 2010*. Wildlife Status Report No. 30. Alberta Sustainable Resource Development. Edmonton, AB. 88 pp.

Alberta Woodland Caribou Recovery Team. 2005. *Alberta Woodland Caribou Recovery Plan 2004/05-2013/14.* Alberta Species at Risk Recovery Plan No. 4. Alberta Sustainable Resource Development, Fish and Wildlife Division. Edmonton, AB. 48 pp.

Athabasca Landscape Team. 2009. *Athabasca Caribou Landscape Management Options Report*. 75 pp. + Appendices.

AXYS Environmental Consulting Ltd. 1995. *A Compendium of Physical Access Control Measures for Roads and Other Rights-of-Way*. A Component of the Access Management Initiative in Northeastern BC.

AXYS Environmental Consulting Ltd. 2003. Appendix 13D.C *Access Management Plan. Ekwan Pipeline Project Environmental Protection Plan*. Prepared for EnCana Ekwan Pipeline Inc. Calgary, AB.

Bayne, E.M., H. Lankau and J. Tigner. 2011. *Ecologically Based Criteria to Assess the Impact and Recovery of Seismic Lines: The Importance of Width, Regeneration and Seismic Line Density*. Environmental Studies Research Funds Report No. 192. Edmonton, AB. 98 pp.

Bergerud, A.T., H.E. Butler and D.R. Miller. 1984. Antipredator tactics of calving caribou: Dispersion in mountains. *Canadian Journal of Zoology* 62: 1566–1575.

Bijlsma, R., J. Bundgaard and A.C. Boerema. 2000. Does inbreeding affect the extinction risk of small populations? Predictions from *Drosophila*. *Journal of Evolutionary Biology* 13(3): 502–514.

Bradshaw, C.J.A., D.M. Hebert, A.B. Rippin and S. Boutin. 1995. Winter peatland habitat selection by woodland caribou in northeastern Alberta. *Canadian Journal of Zoology* 73: 1567–1574.

British Columbia Ministry of Environment. 2011. *Interim Operating Practices for Oil and Gas Ac tivities in Identified Boreal Caribou Habitat in British Columbia*. September 22, 2011. Website:http:/ /www.env.gov.bc.ca/wld/speciesconservation/bc/documents/Operating%20Practices.pdf. Accessed September 2012.

British Columbia Ministry of Forests. 1997. *Silviculture Prescriptions Field Methods Book*. Interim Draft. Victoria, BC. Available online at: https://www.for.gov.bc.ca/hfd/pubs/docs/sil/Sil411/Sil411.htm. Accessed: April 2015.

Brown, G.S., W.J. Rettie, R.J. Brooks and F.F. Mallory. 2007. Predicting the impacts of forest management on woodland caribou habitat suitability in black spruce boreal forest. *Forest Ecology and Management* 245: 137–147.

Brown, W.K., J. Huot, P. Lamothe, S.N. Luttich, M. Pare, G. St. Martin and J.B. Theberge. 1986. The distribution and movement patterns of four woodland caribou herds in Quebec and Labrador. *Rangifer Special Issue* 1: 43–49.

Camill, P. 1999. Patterns of boreal permafrost peatland vegetation across environmental gradients sensitive to climate warming. *Canadian Journal of Botany* 77: 721–33.

Canada's Oil Sands Innovation Alliance. 2012. *COSIA*. Website: http://www.cosia.ca/. Accessed: March 2015.

Canadian Standards Association. 2011. *Z662-11 Oil and Gas Pipeline Systems*. Reprinted January 2012. 555 pp.

Caribou Range Restoration Project. 2007a. *Permanent Sample Plot Manual for the Caribou Range Restoration Project in Alberta, March 23, 2007*. Draft Unpublished Document.

Caribou Range Restoration Project. 2007b. *Caribou Range Restoration Project: Guidelines for Planning and Implementation*. Unpublished document created for the West–Central Alberta Petroleum Producers Group, Canadian Association of Petroleum Producers and Environment Canada. September 19, 2007.

Caribou Range Restoration Project. 2007c. *Little Smoky Caribou Habitat Restoration Pilot Project Summary*. Unpublished document prepared for Suncor Energy, ConocoPhillips Canada, Canadian Forest Products and Alberta Newsprint Co.

CH2M HILL Energy Canada, Ltd. 2014. *Environmental and Socio-Economic Assessment for the Proposed NOVA Gas Transmission Ltd. Liege Lateral Loop 2 – Thornbury Section Pipeline and the Leismer East Compressor Station Project*. Prepared for NOVA Gas Transmission Ltd. September 2014.

Cibrowski, J.J.H., A. Grgicak-Mannion, M. Kang, R. Rooney, Z. Hongcheng, K. Kovalenko, S.E. Bayley and A.L. Foote. 2012. *Development of a Regional Monitoring Program to Assess the Effects of Oil Sands Development on Wetland Communities Final Report*. Submitted to the Cumulative Environmental Management Association (CEMA). CEMA Contract. 2010-0029.

Collins, W.B. and T.S. Smith. 1991. Effects of wind-hardened snow on foraging by reindeer (*Rangifer tarandus*). *Arctic* 44(3): 217–222.

Committee on the Status of Endangered Wildlife in Canada. 2002. *COSEWIC Assessment and Update Status Report on the Woodland Caribou* Rangifer tarandus *Caribou in Canada*. Ottawa, ON. xi + 98 pp.

Committee on the Status of Endangered Wildlife in Canada. 2011. *Designatable Units for Caribou (*Rangifer tarandus*) in Canada*. Ottawa, ON. 88 pp.

Committee on the Status of Endangered Wildlife in Canada. 2015. *Canadian Species at Risk*. Website: http://www.cosewic.gc.ca/eng/sct5/index_e.cfm. Accessed: April 2015.

Courtin, P.J. and K.R. Brown. 2001. *The Use of Red Alder to Enhance Sitka Spruce Growth in the Queen Charlotte Islands*. Forest Research Extension Note EN-008. BC Ministry of Forests, Vancouver Forest Region. Nanaimo, BC. 4 pp.

Courtois, R. and J.P. Ouellet. 2007. Modelling the impact of moose and wolf management on persistence of woodland caribou. *Alces* 43: 13–27.

DeCesare, N.J., M. Hebblewhite, F. Schmiegelow, D. Hervieux, G.J. McDermid, L. Neufeld, M. Bradley, J. Whittington, K.G. Smith, L.E., Morgantini, M. Wheatley and M. Musiani. 2012. Transcending scale dependence in identifying habitat with resource selection functions. *Ecological Applications* 22(4): 1068–1083.

Diversified Environmental Services. 2004. *Canadian Natural Resources Ltd. Ladyfern Pipeline d-87-H/94-H-1, British Columbia to NE Section 20- Township 94-Range 12 W6M, Alberta: Revegetation Monitoring Report Year 2 (2003)*. Prepared for: Canadian Natural Resources Ltd. 18 pp. + Appendices.

Dyer, S.J. 1999. *Movement and Distribution of Woodland Caribou (*Rangifer tarandus caribou*) in Response to Industrial Development in Northeastern Alberta*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. *Journal of Wildlife Management* 65(3): 531–542.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2002. Quantifying barrier effects of roads and seismic lines on movements of female woodland caribou in northeastern Alberta. *Canadian Journal of Zoology* 80(5): 839–845.

Edmonds, E.J and M. Bloomfield. 1984. *A Study of Woodland Caribou (*Rangifer tarandus caribou*) in West-Central Alberta, 1979 to 1983*. Alberta Energy and Natural Resources, Fish and Wildlife Division. Edmonton, AB.

Ehlers, L.P.W., C.J. Johnson and D.R. Seip. 2014. Movement ecology of wolves across an industrial landscape supporting threatened populations of woodland caribou. *Landscape Ecology* 29(3): 451–465.

Enbridge Pipelines (Athabasca) Inc. 2010. *Waupisoo Pipeline Project: 2010 Green Area Post-Construction Reclamation Assessment*. Submitted to Alberta Sustainable Resource Development.

Environment Canada. 2011. *Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada: 2011 Update*. Ottawa, ON. 103 pp.

Environment Canada. 2012. *Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada*. *Species at Risk Act* Recovery Strategy Series. Ottawa, ON. xi + 138 pp.

Environment Canada. 2015. *Species at Risk Public Registry*. Website: http://www.sararegistry.gc.ca/species/default_e.cfm. Accessed: April 2015.

Esri User Conference. 1996. *1996 User Conference Proceedings*. Esri User Conference. Website: http://proceedings.esri.com/library/userconf/proc96/WELCOME.HTM. Accessed: April 2015.

Frankham, R. 2005. Genetics and extinction. *Biological Conservation* 126(2): 131–140.

Girard, M., C. Lavoie and M. Thériault. 2002. The regeneration of a highly disturbed ecosystem: A mined peatland in southern Québec. *Ecosystems* 5: 274–288.

Golder Associates Ltd. 2005. *Firebag Project 2004 Seismic Line Reclamation Study Annual Report*. Submitted to: Suncor Firebag Inc.

Golder Associates Ltd. 2007. *Audit of Operating Practices and Mitigation Measures Employed Within Woodland Caribou Ranges*. Submitted to Caribou Landscape Management Association. Peace River, AB.

Golder Associates Ltd. 2009. *Caribou Habitat Restoration Pilot Study*. Prepared for Conoco Phillips Canada, Suncor Energy and Canadian Association of Petroleum Producers. 41 pp.

Golder Associates Ltd. 2010. *Canadian Natural Resources Limited: Primrose and Wolf Lake: Wildlife Habitat Enhancement Program Development and Implementation*. Submitted to: Canadian Natural Resources Ltd. Calgary, AB.

Golder Associates Ltd. 2011. *Waupisoo Pipeline 2011 Seedling Monitoring Plot Summary*. Submitted to Enbridge Pipelines (Athabasca) Inc.

Golder Associates Ltd. 2012a. *Boreal Caribou Habitat Restoration*. Prepared for: Ministry of Forests, Lands and Natural Resource Operations. Fish Wildlife and Habitat Management Branch, Government of British Columbia. Prince George, BC. 24 pp.

Golder Associates Ltd. 2012b. *Interconnect Pipeline 2011 Seedling Monitoring Plot Summary*. Memo submitted to CNRL February 23, 2012.

Golder Associates Ltd. 2014. *Final Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Leismer to Kettle River Crossover Project*. Prepared for NOVA Gas Transmission Ltd.

Golder Associates Ltd. 2015. *Boreal Caribou Habitat Restoration Operational Toolkit for British Columbia*. Prepared for BC Science and Community Environmental Knowledge (SCEK) Fund's Research and Effectiveness Monitoring Board (REMB). Calgary, AB.

Government of Alberta. 2011. *A Woodland Caribou Policy for Alberta*. 2 pp.

Hawkes, V.C. 2011. *Early Successional Wildlife Monitoring On Reclamation Plots in the Athabasca Oil Sands Region*. British Columbia Mine Reclamation Symposium. British Columbia Technical and Research Committee on Reclamation, Vancouver, BC.

Hedrick, P.W. and S.T. Kalinowski. 2000. Inbreeding depression in conservation biology. *Annual Review of Ecology and Systematics* 31: 139–162.

Hervieux, D., M. Hebblewhite, N.J. DeCesare, M. Russell, K. Smith, S. Robertson and S. Boutin. 2013. Widespread declines in woodland caribou (*Rangifer tarandus caribou*) continue in Alberta. *Canadian Journal of Zoology* 91(12): 872–882.

Hunt, L.M. and M. Hupf. 2014. The effectiveness of road closures and deactivations at reducing traffic: A case of resource roads used for recreational activities in Ontario, Canada. *The Forestry Chronicle* 90(5): 670–677.

James, A.R.C. 1999. *Effects of Industrial Development On the Predator–Prey Relationship Between Wolves and Caribou in Northeastern Alberta*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

James, A.R.C. and A.K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. *Journal of Wildlife Management* 64: 154–159.

James, A.R.C., S. Boutin, D.M. Hebert and A.B. Rippin. 2004. Spatial separation of caribou from moose and its relation to predation by wolves. *Journal of Wildlife Management* 68: 799–809.

Keller, L.F. and D.M. Waller. 2002. Inbreeding effects in wild populations. *Trends in Ecology and Evolution* 17(5): 230–241.

Khasa, P.D., L. Sigler, P. Chakravarty, B.P. Dancik, L. Erikson and D. Mc Curdy. 2001. Effect of fertilization on growth and ectomycorrhizal development of container-grown and bare-root nursery conifer seedlings. *New Forestry* 22: 179–197.

Kuehl, R.O. 2000. *Design of Experiments: Statistical Principles of Research Design and Analysis*. (2nd ed.). Brooks/Cole. Pacific Grove, CA.

LaPerriere, A.J. and P.C. Lent. 1977. Caribou feeding sites in relation to snow characteristics in northeastern Alaska. *Arctic* 30: 101–108.

Latham, A.D.M. 2009. *Wolf Ecology and Caribou-Primary Prey-Wolf Spatial Relationships in Low-Productivity Peatland Complexes in Northeastern Alberta*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

Latham, A.D.M., M.C. Latham, N.A. McCutchen and S. Boutin. 2011. Invading white-tailed deer change wolf–caribou dynamics in northeastern Alberta. *The Journal of Wildlife Management* 75(1): 204-212.

Lee, P. and S. Boutin. 2006. Persistence and developmental transition of wide seismic lines in the western Boreal Plains of Canada. *Journal of Environmental Management*. 78: 240–250.

Macadam, A. and L. Bedford. 1998. Mounding in the Sub-Boreal Spruce Zone of west-central British Columbia: 8-year results. *The Forestry Chronicle* 74(3): 421–427.

MacDonald, E., S. Quideau and S. Landhäusser. 2012. Rebuilding boreal forest ecosystems after industrial disturbance. Pp 123-159 in *Restoration and Reclamation of Boreal Ecosystems*. D.H. Vitt and J.S. Bhatti, (Eds.). Cambridge University Press, Cambridge, UK.

MacFarlane, A.K. 1999. *Revegetation of Wellsites and Seismic Lines in the Boreal Forest*. B.Sc. Honour's Thesis, University of Alberta. Edmonton, AB.

MacFarlane, A.K. 2003. *Vegetation Response to Seismic Lines: Edge Effects and Online Succession*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

MacIsaac, D.A., G.R. Hillman and P.A. Hurdle. 2004. *Alternative Silvicultural Systems for Harvesting and Regenerating Spruce-Dominated Boreal Mineral Wetlands*. Canadian Forest Service, Northern Forestry Centre. Information Report Nor-X-399.

McCutchen, N.A. 2007. *Factors Affecting Caribou Survival in Northern Alberta: The Role of Wolves, Moose and Linear Features*. Ph.D. Dissertation, University of Alberta. Edmonton, AB.

McKay, T., K. Graham and G. Stenhouse. 2014. *Grizzly Bears and Pipelines: Response to Unique Linear Features*. Year 2 (2013) Final Report. Alberta Upstream Petroleum Research Fund (13-AU-ERPC-03). Foothills Research Institute Grizzly Bear Program. Hinton, AB.

McKenzie, H.W., E.H. Merrill, R.J. Spiteri and M.A. Lewis. 2012. How linear features alter predator movement and the functional response. *Interface Focus* 2(2): 205–216.

McLoughlin, P.D., E. Dzus, B. Wynes and S. Boutin. 2003. Declines in populations of woodland caribou. *The Journal of Wildlife Management* 67(4): 755–761.

McNay, R.S., G. Sutherland, L. Giguere, J. Gollner, K. Sittler, F. MacDonald and V. Brumovsky. 2014. *Multi-Scale Responses by Predators and Prey to Deactivation/Restoration of Disturbance Features – Individual and Population Components*. Interim Report 2013-2014. Wildlife Infometrics Report 470, Wildlife Infometrics Inc. Mackenzie, BC.

Montgomery, D.C. 2001. Design and Analysis of Experiments. (5th ed.). John Wiley and Sons Inc. New York, NY.

Naeth, M.A., D.J. White, D.S. Chanasyk, T.M. Macyk, C.B. Powter and D.J. Thacker. 1991. *Soil Physical Properties in Reclamation*. Alberta Land Conservation and Reclamation Council Report No. RRTAC 91-4. Edmonton, AB.

Neufeld, L.M. 2006. *Spatial Dynamics of Wolves and Woodland Caribou in an Industrial Forest Landscape in West–Central Alberta*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

North American Caribou Workshop. 2014. *Caribou Conservation and Management: What's Working?* Website: http://www.2014nacw.ca/Portals/10/NACWprogramfinal_web.pdf. Accessed: April 2015.

NOVA Gas Transmission Ltd. 2014a. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 1*. Hearing Order N081-2014. November 14, 2014.

NOVA Gas Transmission Ltd. 2014b. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 2*. Hearing Order N081-2014. December 19, 2014.

NOVA Gas Transmission Ltd. 2015. *Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project Response to Information Request No. 3.* Hearing Order N081-2014. January 7, 2015.

O'Brien, D., M. Manseau and A. Fall. 2006. Testing the importance of spatial configuration of winter habitat for woodland caribou: An application of graph theory. *Biological Conservation* 130: 70–83.

Oberg, P.R. 2001. *Responses of Mountain Caribou to Linear Features in a West–Central Alberta Landscape*. M.Sc. Thesis, University of Alberta. Edmonton, AB.

Ohlson, D. 2014. *SM 800 – Linear Footprint and Access Management*. CEMA Linear Footprint Task Group Stony Mountain 800 Multi-Stakeholder Planning Pilot. Cumulative Environmental Management Association. Fort McMurray, AB. 209 pp.

Osko, T. and M. Glasgow. 2010. *Removing the Wellsite Footprint: Recommended Practices for Construction and Reclamation of Wellsites on Upland Forests in Boreal Alberta*. University of Alberta, Department of Biological Sciences. Edmonton, AB. 61 pp.

Osko, T. J. and A. K. MacFarlane. 2000. *Natural Reforestation Rates on Seismic Lines and Wellsites in Comparison to Natural Burns Or Logged Sites*. Alberta–Pacific Forest Industries. Boyle, AB.

Peters, W., M. Hebblewhite, N. DeCesare, F. Cagnacci and M. Musiani. 2013. Resource separation analysis with moose indicates threats to caribou in human altered landscapes. *Ecography* 34(4): 487–498.

Polster, D.F. 2002. Soil bioengineering techniques for riparian restoration. In *Proceedings of the 26th Annual British Columbia Mine Reclamation Symposium*. Dawson Creek, BC. 230–239.

Pyper, M. and T. Vinge, 2012. *A Visual Guide to Handling Woody Materials for Forested Land Reclamation.* Report No. TR-31. University of Alberta, School of Energy and the Environment, Oil Sands Research and Information Network. Edmonton, AB. 10 pp.

Rettie, W.J. and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. *Canadian Journal of Zoology* 76: 251–259.

Rettie, W.J. and F. Messier. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. *Ecograph*y 23: 466–478.

Revel, R. D., T. D. Dougherty and D. J. Downing. 1984. *Forest Growth and Revegetation Along Seismic Lines*. University of Calgary Press. Calgary, AB.

Ripple, W. J. and R. L. Beschta. 2004. Wolves and the ecology of fear: Can predation risk structure ecosystems? *BioScience* 54(8): 755–766.

Ripple, W. J., J. A. Estes, R. L. Beschta, C. C. Wilmers, E. G. Ritchie, M. Hebblewhite, J. Berger, B. Elmhagen, M. Letnic, M. P. Nelson, O. J. Schmitz, D. W. Smith, A. D. Wallach and A. J. Wirsing. 2014. Status and ecological effects of the world's largest carnivores. *Science* 343(6167): 1241484.

Robinson, S.D. and Moore, T.R. 2000. The influence of permafrost and fire upon carbon accumulation in high boreal peatlands, Northwest Territories, Canada. *Arctic, Antarctic and Alpine Research* 32: 155–166.

Rohner, C. and G. Kuzyk. 2000. *Wolves and Caribou in West–Central Alberta: Predator Responses to Industrial Resource Development*. Research News 3, University of Alberta and West–Central Caribou Standing Committee. Edmonton, AB. 4 pp.

Roy, V., P.-Y. Bernier, A.P. Plamondon and J.-C. Ruel. 1999. Effect of drainage and microtopography in forested wetlands on the microenvironment and growth of planted black spruce seedlings. *Canadian Journal of Forest Research* 29: 563–574.

Sanborn, P., R. Brockley and C. Preston. 2001. *Effects of Sitka Alder Retention and Removal on the Growth of Young Lodgepole Pine in the Central Interior of British Columbia (EP 1185): Establishment Report*. Working Paper 60/2001. BC Ministry of Forests, Research Branch. Victoria, BC. 44 pp.

Schaefer, J.A. and W.O. Pruitt. 1991. Fire and woodland caribou in southeastern Manitoba. *Wildlife Monographs* 116: 1–39.

Seip, D.R. and D.B. Cichowski. 1996. Population ecology of caribou in British Columbia. *Rangifer* 9: 73-80.

Serrouya, R., D. Paetkau, B.N. McLellan, S. Boutin, M. Campbell and D.A. Jenkins. 2012. Population size and major valleys explain microsatellite variation better than taxonomic units for caribou in western Canada. *Molecular Ecology* 21(11): 2588–2601.

Sherrington, P.M. 2003. *Measuring Boreal Forest Fragmentation Change in Response to Seismic Line, Wellsite and Road Revegetation With Scanned False-Colour Infrared Aerial Photography*. MGIS Thesis, University of Calgary. Calgary, AB.

Simard, S. and J. Heineman. 1996. *Nine-Year Response of Lodgepole Pine and the Dry Alder Complex to Chemical and Manual Release Treatments on an ICHmk1 Site Near Kelowna*. FRDA Report 259. BC Ministry of Forests. Kamloops, BC. 19 pp.

Stantec Consulting Limited. 2014. *Final Caribou Habitat Restoration Plan for the Chinchaga Lateral Loop No. 3 (Chinchaga Section)*. Prepared for NOVA Gas Transmission Ltd. Calgary, AB.

Stokes, D., S. Duncan and J.R. Turner. 2009. *An Adaptive Approach to Reclaiming the First Coal Corporation Central South Property*. British Columbia Mine Reclamation Symposium 2009.

Straker, J. and G. Donald. 2011. *Assessing Re-Establishment of Functional Forest Ecosystems on Reclaimed Oil Sands Mine Lands*. British Columbia Mine Reclamation Symposium. British Columbia Technical and Research Committee on Reclamation, Vancouver, BC.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. *The Journal of Wildlife Management* 61: 622–633.

Sweeney, S. 2005. Alder: The nitrogen fix: Ontario trees and shrubs. *The Monday Garden* 151. February 13, 2005.

Switalski, T.A. and C.R. Nelson. 2011. Efficacy of road removal for restoring wildlife habitat: Black bear in the northern Rocky Mountains, USA. *Biological Conservation* 144(2011): 2666–2673.

Tedder, W.S. and L.W. Turchenek. 1996. Natural revegetation of an Alberta peatland after horticultural peat extraction. In *4th Annual Canadian Peatland Restoration Workshop, 13–14 July, Quebec City, Canada*. Universite Laval, Faculte des Sciences de Sciences de L'agriculture et de .l'alimentation. Quebec City, QC.

TERA Environmental Consultants. 2011a. *Caribou Habitat Restoration Plan for the Proposed NOVA Gas Transmission Ltd. Horn River Mainline Project, Part II*. Updated September 2011. Prepared for NOVA Gas Transmission Ltd.

TERA Environmental Consultants. 2011b. *Post-Construction Monitoring Report for the Trans Mountain Pipeline L.P. TMX – Anchor Loop Project*. Prepared for Trans Mountain Pipeline L.P. December 2011. 78 pp. + Appendices.

TERA Environmental Consultants. 2012. *Supplemental Update for the Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Horn River Mainline Project, Part II*.

TERA Environmental Consultants. 2014a. *Final Caribou Habitat Restoration Plan for the NOVA Gas Transmission Ltd. Northwest Mainline Expansion*. Prepared for NOVA Gas Transmission Ltd.

TERA Environmental Consultants. 2014b. *Traditional Knowledge Report (NEB Filing ID A4C2V4) for the Proposed NOVA Gas Transmission Ltd. Liege Lateral Loop 2 (Thornbury Section) Project* Prepared for NOVA Gas Transmission Ltd.

Thomas, D.C. and D.R. Gray. 2002. Update COSEWIC status report on the woodland caribou *Rangifer tarandus caribou* in Canada. In *COSEWIC Assessment and Update Status Report on the Woodland Caribou* Rangifer tarandus caribou *in Canada*. Committee on the Status of Endangered Wildlife in Canada. Ottawa, ON. 98 pp.

Thurber, J.M., R.O. Peterson, T.D. Drummer and S.A. Thomasma. 1994. Gray wolf response to refuge boundaries and roads in Alaska. *Wildlife Society Bulletin* 22: 61–68.

Turetsky, M.R., R.K. Wieder, C.J. Williams and D.H. Vitt. 2000. Organic matter accumulation, peat chemistry, and permafrost melting in peatlands of boreal Alberta. *Écoscience* 7: 379–392.

Vinge, T. (unpublished). *Treatment Matrix for Linear Restoration*. 2014.

Vinge, T. and M. Pyper. 2012. *Managing Woody Materials on Industrial Sites: Meeting Economic, Ecological and Forest Health Goals Through a Collaborative Approach*. University of Alberta, Department of Renewable Resources. Edmonton, AB. 32 pp.

Vistnes, I. and C. Nellemann. 2001. Avoidance of cabins, roads and power lines by reindeer during calving. *Journal of Wildlife Management* 65: 915–925.

Westland Resource Group. 2011. *TMX Anchor Loop Project: Wildlife and Wildlife Habitat Post Construction Monitoring Year 2 Report*. Prepared for Kinder Morgan Canada c/o TERA Environmental Consultants.

Whittington, J., M. Hebblewhite, N.J. DeCesare, L. Neufeld, M. Bradley, J. Wilmshurst and M. Musiani. 2011. Caribou encounters with wolves increase near roads and trails: A time-to-event approach. *Journal of Applied Ecology* 48: 1535–1542.

Wittmer, H.U., A.R.E. Sinclair and B.N. McLellan. 2005. The role of predation in the decline and extirpation of woodland caribou. *Oecologia* 144: 257–267.

Zager, P. and J. Beecham. 2006. The role of American black bears and brown bears as predators on ungulates in North America. *Ursus* 17(2): 95–108.

9.2 GIS DATA AND MAPPING REFERENCES

This subsection includes references cited in the figures accompanying this report.

AESRD. 2014. *Alberta Wildfire Perimeters: 1931 to 2013(digital file)*. Edmonton, AB. Available: http://esrd.alberta.ca/wildfire/wildfire-maps/historical-wildfire-information/spatial-wildfire-data.aspx. Acquired: April 30, 2014. Update Interval: Annually.

Alberta Environment and Sustainable Resource Development. 2013. *Caribou Range* (digital file). Edmonton, AB. Available: http://esrd.alberta.ca/forms-maps-services/maps/wildlife-sensitivity-maps/default.aspx. Acquired: April 2013. Last Update Check: February 20, 2015.

Alberta Environment and Sustainable Resource Development. 2014. *Key Wildlife and Biodiversity Zone* (digital file). Edmonton, AB. Available: http://esrd.alberta.ca/forms-maps-services/maps/wildlife-sensitivity-maps/default.aspx. Acquired: March 2014. Last Update Check: February 20, 2015.

Alberta Tourism, Parks and Recreation. 2012. *Protected Areas* (pashape_ocsites_10tm) (digital file). Edmonton, AB. Available: http://albertaparks.ca/albertaparksca/library/downloadable-data-sets.aspx. Acquired: February 2013. Last Update Check: November 7, 2014.

AltaLIS. 2009. *Alberta Township System Version 4.1* (digital file). Calgary, AB. Available: http://www.altalis.com. Acquired: October 2009. Last Update Check: June 5, 2014.

BlackBridge Geomatics. 2015. *SPOT6 1.5 m Colour Satellite Imagery* (digital file). Lethbridge, AB. Available: www.blackbridge.com. Acquired: December, 2014.

Government of Canada. 2014. *Aboriginal Lands, Canada* (digital file). Edmonton, AB. Available: http://www.geobase.ca. Acquired: January 2015. Last Update Check: January 15, 2015.

IHS Inc. 2014. *IHS Facility Data* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. *IHS Enhanced Pipeline Data* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. *IHS Road Segments* (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

IHS Inc. 2015. IHS Wells - Surface Hole (digital file). Calgary, AB. Received: via DVD, visit http://www.ihs.com for more info. Acquired: February 17, 2015. Update Interval: Monthly.

Natural Resources Canada. 2003. *Canadian Geographical Names* (digital file). Ottawa, ON. Available: http://geobase.ca/geobase/en/data/cgn/index.html. Acquired: June 2014. Last Update Check: January 6, 2015.

Natural Resources Canada. 2007-2011. *National Hydro Network* (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/nhn/index.html. Acquired: April 2012. Last Update Check: May 2012.

Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. 2009. *Land Cover, Circa 2000 – Vector* (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/landcover/index.html. Acquired: September 2009. Last Update Check: November 2011.

Natural Resources Canada. 2014. *National Road Network – Alberta* (digital file). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/nrn/index.html. Acquired: September 2014. Last Update Check: January 2, 2015.

TERA, a CH2M HILL Company. 2008. *Hillshade*. Derived from Natural Resources Canada, Earth Sciences Sector, Centre for Topographic Information. 2000–2008. Canadian Digital Elevation Data 250k (digital files). Sherbrooke, QC. Available: http://www.geobase.ca/geobase/en/data/cded/index.html. Acquired: 2008. Last Update Check: December 2010.

TransCanada 2014. *Leismer East Compressor Station* (digital files). Calgary, AB. Acquired: June 2014. Last Update Check: June 2, 2014.

TransCanada 2014. *Liege Lateral Loop 2 – Thornbury Section Pipeline, KPs* (digital files). Calgary, AB. Acquired: November 2014. Last Update Check: November 18, 2014.

TransCanada. 2014. *Access Road, Government Road Allowance* (digital files). Calgary, AB. Received: October 31, 2014.

TransCanada. 2014. *Contingency Crossing Location* (digital file). Calgary, AB. Received May 9, 2014.

TransCanada. 2014. *Existing Compressor Station* (digital files). Calgary, AB. Received: June 23, 2014.