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February 1, 2018

Filed Electronically

National Energy Board
Suite 210, 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)
Order XG-N081-003-2015 (Order)
Amending Order AO-002-XG-N081-003-2015
Condition 8 – Final Caribou Habitat Restoration and Offset Monitoring Program (Monitoring Program)
NEB File: OF-Fac-Gas-N081-2014-11 01

In accordance with Condition 8 of the Order, enclosed is the Final Monitoring Program for the Project. The Project was approved by the National Energy Board (NEB or Board) on January 28, 2015 in Order XG-N081-003-2015, and as amended by Amending Order AO-002-XG-N081-003-2015 issued on May 3, 2016.[1,2]

If the Board requires additional information with respect to this filing, please contact me by phone at (403) 920-2174 or by email at roselyn_chou@transcanada.com.

Yours truly,
NOVA Gas Transmission Ltd.

Original signed by

Roselyn Chou
Regulatory Project Manager
Regulatory Facilities, Canada Gas Pipelines

Enclosures

cc: Paul Gregoire, Wildlife Biologist, Environment and Climate Change Canada
Joann Skilnick, Senior Wildlife Biologist, Alberta Environment and Parks
James Grier, Forestry Officer, Alberta Environment and Parks
Christa MacNevin, Wildlife Officer, Alberta Environment and Parks

[1] NEB Filing ID: A65564.
[2] NEB Filing ID: A76723.

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1.0 INTRODUCTION

NOVA Gas Transmission Ltd. (NGTL) applied under section 58 of the *National Energy Board Act* (NEB Act) on September 19, 2014 to construct and operate the Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project (Project). The National Energy Board (NEB) issued Order XG-N081-003-2015 and as amended by Amending Order AO-002-XG-N081-003-2015 issued on May 3, 2016 (collectively, the Order) pursuant to Section 58 of the NEB Act, approving the Project, subject to certain conditions including Condition 8, which defines the requirements for the filing of a Caribou Habitat Restoration and Offset Measures Monitoring Program (Monitoring Program).

NGTL developed this Monitoring Program to monitor and verify the effectiveness of caribou habitat restoration and offset measures implemented as part of the Project's Caribou Habitat Restoration Plan (CHRP). Project effects on caribou habitat include direct disturbance on the Project footprint, indirect disturbance to surrounding habitat, and remaining residual effects. The details of this Monitoring Program are consistent with the primary principles used to guide previous NGTL caribou habitat restoration and offset monitoring programs, but now also incorporates continual improvements based on lessons learned and adaptive management. This includes information from a previously approved Monitoring Program that was filed with the NEB on August 4, 2015[1] to comply with the following NEB conditions:

- Certificate GC-119, Condition 24 for the Northwest Mainline Expansion Project (NWML);
- Certificate GC-120, Condition 19 for the Leismer to Kettle River Crossover Project (Leismer); and,
- Certificate GC-121, Condition 21 for the Chinchaga Lateral Loop No. 3 Project (Chinchaga).

This Monitoring Program has also been prepared with consideration for Operational Policy Statement for Follow-Up Programs under the *Canadian Environmental Assessment Act* (CEAA; CEA Agency 2011).

1.1 ORDER CONDITIONS

This Monitoring Program has been prepared in accordance with Condition 8 of NEB Order XG-N081-003-2015. See Table 1-1 for the condition requirements, details, and locations of those requirements in this report.

Approval for the Project was also subject to the following conditions relating to effects on caribou habitat:

[1] NEB Filing ID: A71613.

- Condition 6 – NGTL filed a final Caribou Habitat Restoration Plan (CHRP) for the Project on November 1, 2017, to mitigate the effects of the Project footprint on caribou habitat.[2]
- Condition 7 – NGTL filed a preliminary Offset Measures Plan (OMP), for the Project on December 23, 2015.[3] The final OMP will be filed by February 1, 2019 after the second growing season following the commencement of operations.
- Condition 9 – NGTL will file the results of the Monitoring Program in accordance with the schedule outlined in Section 6.

[2] NEB Filing ID: A87455 as well as subsequent errata filings to the CHRP (NEB Filing IDs: A88198, A89273).
[3] NEB Filing ID: A74936-1.

Table 1-1: Order Conditions: Caribou Habitat Restoration and Offset Measures Monitoring Program[1]

Condition 8	DETAILS AND LOCATION IN REPORT
NGTL shall file with the Board, for approval, on or before 1 February after the first complete growing season following the commencement of operation of the project, a program for monitoring and verifying the effectiveness of the caribou habitat restoration and offset measures implemented as part of the final Caribou Habitat Restoration Plan (CHRP) and final Offset Measures Plan (OMP). The CHROMMP shall include, but not be limited to:	
a) The scientific methodology or protocol for short-term and long-term monitoring of the restoration and offset measures, and their actual effectiveness based on monitoring results;	Section 4 provides the scientific methods and protocols for short-term and long-term monitoring of CHRP and OMP measures, including the experimental design and statistical methods used to verify measure effectiveness. Actual effectiveness based on monitoring results is also described in Sections 4 and 6.
b) Frequency, timing, and locations of monitoring and the rationale for each choice;	Section 6 provides the monitoring program schedule, including frequency, timing and monitoring locations.
c) Protocols for how restoration and offset measures will be adapted, as required, based on the monitoring results from the implementation of either this Project or NGTL CHRPs and OMPs for other projects; and,	Section 5 discusses how CHRP and OMP measures will be adapted (i.e., adaptive management) based on the monitoring results or lessons learned throughout the duration of the monitoring program, including peer-reviewed literature or provincial guidelines (Action Plans and Range Plans) when available.
d) A schedule for filing reports of monitoring results and adaptive management responses to the Board, EC and Alberta Environment and Sustainable Resource Development. This schedule shall be contained in the CHROMMP as well as in the reports required under Condition 9.	Section 6 provides a schedule for filing reports concerning monitoring results and adaptive management responses to the Board, ECCC and AEP.[2] Section 2 describes the application of modifications to this Monitoring Program based on learnings gained from prior caribou filings, in alignment with adaptive management principles.

Note:
1. Abbreviations: CHROMMP – Caribou Habitat Restoration and Offset Measures Monitoring Program; CHRP – Caribou Habitat Restoration Plan; EC – Environment Canada; OMP – Offset Measures Plan.
2. In 2014, the responsibilities of Alberta Environment and Sustainable Resource Development was granted to the newly formed Alberta Environment and Parks (AEP). In 2015 after the federal election, Environment Canada was renamed Environment and Climate Change Canada (ECCC).

1.2 ORGANIZATION OF THE MONITORING PROGRAM

While NGTL submits this Monitoring Program for the Project in accordance with Condition 8 of the Order, NGTL notes that the Monitoring Program, as described through Sections 3 to 5 represents NGTL's overarching program to monitor caribou habitat restoration and offset measures across all of its projects. Sections 1, 2 and 6 provide information specific to the Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Project. Section 2 also includes a table that outlines all updates to NGTL's Monitoring Program since the filing of its first monitoring program. This program is organized as follows:

Section1: Introduction and Organization

Section 2: Modifications to the Program

Section 3: Objectives

Section 4: Monitoring Plan

Section 5: Adaptive Management and Continual Improvement

Section 6: Schedule for Monitoring and Reporting

Section 7: References

2.0 MODIFICATIONS TO THE MONITORING PROGRAM

2.1 UPDATES BY MONITORING ACTIVITY

Specific updates or modifications based on learnings from NGTL's preceding caribou-related filings have been incorporated into this Monitoring Program on the basis of adaptive management. The following sections summarize the modifications. See the table below (Table 2-1) for further details.

2.1.1 Aerial Monitoring

LiDAR will be deferred to Year 3 of future monitoring programs for the following reasons:

- small size of the tree seedlings at Year 1
- LiDAR cannot differentiate between plant species at Year 1
- low seedling height combined with tall grass make it difficult to identify tree stems and percent cover in Year 1

2.1.2 Ground Based Monitoring

Non-palatable shrubs were previously listed as an evaluation criterion, but they were not evaluated. Based on the following, it was determined that palatability measures would not provide a valuable measure of success.

- natural regeneration of palatable species such as aspen, balsam poplar, alder, lodgepole pine, white spruce and birch is considered a desirable outcome of pipeline reclamation
- planting of moderately palatable species including jackpine and lodgepole pine is unavoidable as they are native to the area

2.1.3 Access During Monitoring

Vehicle and all-terrain vehicle (ATV) access during ground-based monitoring and remote camera maintenance will become increasingly difficult as vegetation recovers over the monitoring period. Ground access will create a path to restoration plots which is in conflict with the goals and objectives of this Monitoring Program. NGTL will evaluate access alternatives for future monitoring programs to avoid disturbing restoration areas. As such, LiDAR assessments and other non-ground-based survey methods may become the preferred method of determining if measurable targets are being met in later stages of the program (when vegetation is measurable by LiDAR), with access gained to a subset of ground-truthed sample plots.

2.1.4 Access Control and Line-of-Sight

NGTL acknowledges that some improvements to access control may be possible, however completely inhibiting access is not a likely outcome due to the parallel alignment of different disposition types. Consultation with adjacent disposition holders has been attempted to facilitate coordination of access control measures, with no success to date. Without provincial integrated resource management or agreements with the adjacent disposition holders, it is anticipated that the restoration areas will continue to be accessed. Preliminary draft provincial range plans indicate that all disposition holders will be responsible for coordinating access control along parallel linear features.

Since access control measures and line-of-sight features are ineffective where NGTL parallels adjacent disposition holders, access control and line-of-sight will not be installed or monitored in these locations on future programs without further direction from the province. Also, NGTL will not continue to deploy cameras or monitor where access cannot be fully controlled.

NGTL is consulting with AEP on the issue of recreational and third-party access, and the integrated approach to right-of-way (ROW) restoration. The provincial range plans are expected to address integrated access management on ROWs and protection of restoration areas.

2.1.5 Invasive Species

NGTL foresees that the target of ≥80% cover of native vegetation species in sample plots will be unachievable. Where NGTL parallels adjacent foreign dispositions, such as roads or other linear features, controlling infestations of non-native species has been shown to be only partially successful due to the continual ingress of non-native species from uncontrolled adjacent areas. Species such as clover, were used intentionally to achieve erosion control prior to the requirements for native seed mixes. Since non-native invasive species are not always prohibited and subject to the Weed Control Act, population management is not a requirement.

Non-native invasive species have been identified as a criterion because they have the potential to outcompete planted seedlings and naturally regenerating native tree species, for light, moisture and nutrients. NGTL has revised the target to determine if non-native invasive species are inhibiting the growth of tree seedlings or naturally regenerating tree species (due to overshadowing, percent cover dominance in plots, diminished tree health and vigour). If the answer is “yes”, then the qualified specialist will recommend a corrective action to be implemented (e.g., weed control, seeding). At this stage, NGTL may consider implementing alternative restoration measures to improve site conditions.

2.1.6 Operations and Maintenance

Where pipeline maintenance occurs in restoration areas, access will be routed to/incur the least amount of disturbance. Measures that have to be removed will be replaced after maintenance activities are complete.

An improvement in NGTL's internal communications have resulted in the preservation of the habitat restoration areas and access control measures. NGTL has uploaded all habitat restoration locations to a spatial database and training has been executed to all affected personnel. To the extent possible the caribou habitat restoration areas have been avoided when implementing NGTL's ROW and pipeline maintenance program.

Table 2-1: Modifications to NGTL's Caribou Restoration and Offsets Measures Monitoring Program

Line No.	Previously Filed Caribou Restoration and Offsets Measures Monitoring Program[1]	Modification		Rationale for Modification
		Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Monitoring Program	Reference	
1	Objectives	Outcome, Objectives, Goals and Targets	Section 3	Updated to align with measurable targets and other recent NGTL caribou filings.
2	Aerial surveys collecting LiDAR imagery and 360° photography will be conducted in Q3 of the Year 1, 5, and 15, outside the caribou RAP	LiDAR will not be performed in Year 1. Year 1 LiDAR imagery collection will instead occur in Year 3. The LiDAR imagery collection interval is modified to Q4 of Years 3, 5 and 15, outside of the caribou RAP.	Section 4	Small seedling size in Year 1 results in low detectability success and an inability to differentiate seedlings from surrounding vegetation.
3	≥80% cover of native vegetation species in sample plots	Invasive species are not inhibiting the establishment or sustained growth of planted or naturally regenerating native species	Section 4	The data are available and can be used to demonstrate revegetation success. NGTL has revised wording to demonstrate that the target is the establishment of native species across monitoring plots.
4	Vegetation community composition (percent cover, species present, abundance): • conifer tree • deciduous tree • palatable shrub • non-palatable shrub • herb/graminoid • nonvascular (mosses and lichens) • introduced (non-native, weed, invasive)	Vegetation community composition (percent cover, species present, abundance): • conifer tree • deciduous tree • shrub • herb/graminoid • nonvascular (mosses and lichens) • introduced (non-native, weed, invasive)	Section 4	Natural regeneration of palatable species such as aspen, balsam poplar, alder, lodgepole pine, white spruce and birch is considered a desirable outcome of pipeline reclamation. Planting of moderately palatable species including jackpine and lodgepole pine is unavoidable as they are native to the area.

Table 2-1: Modifications to NGTL's Caribou Restoration and Offsets Measures Monitoring Program (cont'd)

Line No.	Previously Filed Caribou Restoration and Offsets Measures Monitoring Program[1]	Modification		Rationale for Modification
		Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Monitoring Program	Reference	
5	A one-way repeated measures experimental design will be used to evaluate restoration performance for each individual restoration unit separately because of the inherent differences associated with their biophysical characteristics (i.e., treed upland/transitional vs. treed lowlands vs. shrub/graminoid lowlands).	A one-way repeated measures experimental design will be used to evaluate restoration performance for each individual restoration unit separately because of the inherent differences associated with their biophysical characteristics (i.e., treed upland/transitional vs. treed lowlands).Shrub/graminoid lowlands are not considered as a restoration treatment unit and will be considered as a natural regeneration treatment unit, aside from mounded vegetation screen plantings intended as access control or line of site break measures.	Section 4	Shrub/graminoid lowlands are not planted with tree seedlings because tree species are not the dominant cover type for these type of wetlands. Therefore, shrub/graminoid lowland habitat units are considered as natural regeneration, and a full complement (i.e., 13 sites) will be sampled as natural regeneration.
6	Ground-based monitoring will be conducted at randomly placed sample plots within each restoration unit. Preliminary ground-based sample plot locations will be randomly selected and reviewed on the alignment sheets and habitat classification maps in Q2 2015. Final sample plot locations will be verified during reconnaissance field visits in Q3 2015. For NWML and Leismer, 63 ground-based sample plots were identified, sampled and appropriated staked during Q3 2014 (Appendix 1).	Ground-based monitoring will be conducted at randomly placed sample plots within each restoration unit. Preliminary ground-based sample plot locations will be randomly selected and reviewed on the alignment sheets and habitat classification maps in Q2 2018. Final sample plot locations will be verified and surveyed during first year ground-based monitoring in Q3 2018. Plot selection will aim to implement 26 plots representing planted restoration treatment habitat units with 13 plots located in each planted habitat unit (treed upland, treed lowland treed). Aside from planted vegetation screens within mounded line-of-sight breaks, shrub/graminoid lowlands are allowed to regenerate naturally. A total of 13 natural regeneration treatment plots should be implemented in shrub/graminoid	Section 4	Shrub/graminoid lowlands are not planted with tree seedlings because tree species are not the dominant cover type. Therefore, shrub/graminoid lowland habitat units are considered as natural regeneration, and a full complement (i.e., 13 sites) will be sampled as natural regeneration.

Table 2-1: Modifications to NGTL's Caribou Restoration and Offsets Measures Monitoring Program (cont'd)

Line No.	Previously Filed Caribou Restoration and Offsets Measures Monitoring Program[1]	Modification		Rationale for Modification
		Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Monitoring Program	Reference	
6 (cont'd)		lowlands. Finally, an additional 13 plots will be chosen in naturally regenerating treed habitat segments, distributed based on the proportion of treed upland vs treed lowland that is available within the project. For example, if the project is 80% treed upland, 20% treed lowland, natural regeneration plots would be distributed 10 plots in treed upland and 3 plots in treed lowland. The NEB, ECCC, and AEP will be provided final sample plot locations and accompanying maps in the first monitoring report.		
7	Access control targets are designed to prevent access along sections of new alignment of the Project ROW and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term.	Access control targets are designed to prevent access along sections of new alignment of the Project ROW, with the exception of sections paralleling dispositions, and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term.	Section 4	NGTL acknowledges that some improvements to access control may be possible, however completely inhibiting access is not a likely outcome due to the parallel alignment of different disposition types. Consultation with adjacent disposition holders has been attempted to facilitate coordination of access control measures, with no success to date. Without provincial integrated resource management or agreements with the adjacent disposition holders, it is anticipated that the restoration areas will continue to be accessed. Since access control measures are ineffective where NGTL parallels adjacent disposition holders, access control will not be

Table 2-1: Modifications to NGTL's Caribou Restoration and Offsets Measures Monitoring Program (cont'd)

Line No.	Previously Filed Caribou Restoration and Offsets Measures Monitoring Program[1]	Modification		Rationale for Modification
		Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Monitoring Program	Reference	
7 (cont'd)				installed in these locations on future programs. Also, NGTL will not continue to deploy cameras or monitor where access cannot be fully controlled.
8	The distribution of remote camera stations will be determined based on the number of access control and line-of-sight breaks. An equal number of randomly selected camera monitoring stations will be deployed where these measures are not implemented. A minimum distance of 1000 m will be used to spatially separate each camera monitoring station.	The distribution of remote camera stations will be determined based on the number of access control and line-of-sight breaks. An equal number of randomly selected camera monitoring stations will be deployed where these measures are not implemented. A minimum distance of 1000 m will be used to spatially separate each camera monitoring station. Cameras will not be deployed along segments of parallel adjacent dispositions.	Section 4	Consultation with adjacent disposition holders has been attempted to facilitate coordination of access control measures, with no success to date. Without provincial integrated resource management or agreements with the adjacent disposition holders, it is anticipated that the restoration areas will continue to be accessed. Since access control measures are ineffective where NGTL parallels adjacent disposition holders, access control will not be installed in these locations on future programs. Also, NGTL will not continue to deploy cameras or monitor where access cannot be fully controlled.

Table 2-1: Modifications to NGTL's Caribou Restoration and Offsets Measures Monitoring Program (cont'd)

Line No.	Previously Filed Caribou Restoration and Offsets Measures Monitoring Program[1]	Modification		Rationale for Modification
		Liege Lateral Loop 2 (Thornbury Section) and Leismer East Compressor Station Monitoring Program	Reference	
9	From Line-of-Sight Evaluation Criteria (Tables 3-5, 3-6): Woody debris (log)/earth berms: • footprint width • length of berm (perpendicular to ROW) • length of berm with height ≥1.5 m • sight-line model results Vegetation screens: • spatial distribution (distance between live woody stems) • height of live woody stems • percent cover of live woody stems	From Line-of-Sight Evaluation Criteria (Tables 4-5, 4-6): Vegetation screens: • spatial distribution (distance between live woody stems) • height of live woody stems • percent cover of live woody stems	Section 4	NGTL added the extension of bored installations to the access management and line-of-sight measures as a potential habitat conservation/restoration measure where conditions are suitable and the installation method is appropriate. Measures that have proven to be ineffective on prior projects are removed from the toolbox and the decision frameworks on current projects. For example, NGTL has removed earth and woody debris berms as a restoration measure because these features can be counter-effective, affording predators with improved viewsheds. Earth and woody berms also require large amounts of material that are not readily available under normal pipeline construction and therefore deemed impractical. Wood berms have also been deemed a fire hazard by AEP.

Note:
1. NEB Filing ID: A71613.

3.0 OBJECTIVES

This section identifies NGTL's strategic outcome, as well as the objective, goals and targets for the measures discussed throughout the Monitoring Program. These elements have been refined with experience gained across projects and will be used to evaluate the performance and effectiveness of NGTL's caribou habitat restoration and offset measures.

These objective, goals and targets are intended to guide NGTL in the selection and assessment of caribou habitat restoration and offset measures, and reflect an evolution from earlier plans driven by a commitment to continuous improvement.

3.1 STRATEGIC OUTCOME

Combined with the contributions of other parties, NGTL's caribou habitat restoration and offset measures contribute meaningfully to the conservation and recovery of woodland caribou in Canada.

3.2 OBJECTIVE

The objectives of this monitoring program align with previous caribou filings for this project, and include:

- verification that restoration and offset measures achieve their respective targets over the monitoring timeframe;
- implementation of adaptive management to reduce uncertainty associated with the survival and sustainability of habitat restoration and offset measures; and,
- identification of continuous improvement initiatives to better inform the development of future monitoring programs.

NGTL's caribou habitat restoration and offset investments reduce the residual Project effects and offset the Project's contribution to cumulative effects on caribou and caribou habitat in a manner that aligns with provincial and federal policies, management plans and priorities.

3.3 GOALS AND TARGETS

Goal (G1) NGTL's caribou habitat restoration measures are ecologically relevant, practically located and reasonably protected to minimize potential for redisturbance by human activity.

Target (T1) Access is reduced on controlled segments compared with uncontrolled segments.

Target (T2) Continuous improvement of planning tools and environmental management systems to ensure longevity of restoration measures.

Goal (G2) NGTL's caribou habitat restoration and offset measures result in self-sustaining and ecologically appropriate vegetation communities that are on trajectory to the compatible surrounding landscape.

Target (T3) The species composition of habitat restoration and offset areas are on a typical path of ecological succession.

Target (T4) The sustained growth trend of habitat restoration and offset areas is comparable to that of the surrounding landscape.

Target (T2) in this document has been refined from earlier NGTL project caribou restoration plans filed with the NEB. In previously filed habitat restoration and offset measures plans, each of habitat restoration, access management and line-of-sight blocking were defined as targets. Target (T2) was previously related to achievement of a $\leq$500 m sight line when topography and materials allow. In practice and in consultation with stakeholders, line-of-sight reduction is generally a secondary effect of various restoration methods rather than a standalone target (for example planning around landscape features and trenchless crossings can give line-of-sight reduction). As a result of the removal of line-of-sight blocking as a mitigation measure, Target (T2) was updated to reflect NGTL's commitment to protect the restoration and offsetting measures both on- and off-ROW.

4.0 MONITORING PLAN

The goal of the Monitoring Program is to measure and verify the effectiveness of habitat restoration and offset measures. Monitoring outcomes will be integrated into future decision-making as part of an adaptive management and continual improvement process. The Monitoring Program employs a quantitative framework, using both aerial and ground-based sampling protocols, including the deployment of remote cameras.

Areas that are excluded from the Monitoring Program are lands that are granted for other projects/land use, lands that are impacted by forest fires, or other natural disturbances. NGTL will track these activities and events and will provide updates in the monitoring reports (see Section 6 for a reporting schedule).

4.1 EVALUATION CRITERIA AND MEASURABLE TARGETS

The following sections describe the criteria and targets that will be used to verify the effectiveness of the restoration measures.

4.1.1 Habitat Restoration

Evaluation criteria and measurable targets used to verify the effectiveness of habitat restoration measures have been developed in consideration of whether the restored linear features are either operational or non-operational. Operational lines refer to NGTL ROWs or other dispositions currently in operation. Non-operational lines refer to either:

- ROWs still held by NGTL but where ground-based operational access is not typically required; or
- other linear disturbances, such as roads and seismic lines, not held by NGTL but for which NGTL has an agreement with the surface disposition holder that allows for implementation of offset measures.

The development of evaluation criteria and measurable targets for operational and non-operational lines was based on the continued need for NGTL to access caribou habitat restoration and offset measures on its own easements, including AEP access management guidelines for offset measures located off-ROW.

Habitat Restoration Criteria and Targets

Measurable targets will remain the same for each monitoring year and the results will be evaluated at the Year 5 milestone. At Year 5, the monitoring report will identify which restoration areas have met the defined targets, and if the restoration areas require further long-term monitoring at Year 10 and 15.

Table 4-1 presents the evaluation criteria, measurable targets and adaptive management for habitat restoration measures implemented on operational lines, and Table 4-2 presents the evaluation criteria, measurable targets and adaptive management for habitat restoration measures non-operational lines.

Adaptive management strategies will be developed for site-specific locations (see Section 5) where required (Tables 4-3 and 4-4). NGTL will track these site-specific locations and provide updates in its monitoring reports.

Table 4-1: Habitat Restoration Evaluation Criteria and Measurable Targets on Operational Lines[1]

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management

Habitat Restoration	• Aerial Monitoring:
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Performance Surveys
		• Total density of planted seedlings and naturally regenerating seedlings (i.e., from seed ingress or suckering)
		• Height and percent cover of seedlings
		• Vigour of seedlings (evidence of chlorosis, pests/disease, browse, other damage)
		• Vegetation community composition (percent cover, species present, abundance):
		  • conifer tree
		  • deciduous tree
		  • shrub
		  • herb/graminoid
		  • nonvascular (mosses and lichens)
		  • introduced (non-native, weed, invasive)
			Habitat restoration measurable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends following completion of restoration.
			Upland Conifer, Deciduous, Mixedwood and Transitional:
			• Seedling density will vary by species with target range from 1600 to 2000 stems/ha (combined planted seedlings and/or natural regeneration) on sites that are not mounded
			• Invasive species are not inhibiting the establishment or sustained growth of planted or naturally regenerating native tree species
			• Seedling density will vary by species with target range from 800 to 1400 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites, dependent on mound density
			• Spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit (footprint available for restoration)
			• ≥80% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover)
			Treed Lowlands:
			• Natural vegetation is regenerating, including at least two characteristic species (vascular and/or nonvascular; e.g., Carex sp. and Sphagnum moss sp.) (classified as per AWCS 2014)
			• As indicators of healthy vegetation community, no restricted weeds or invasive species such as cattails or reed grass
			• Invasive species are not inhibiting the establishment or sustained growth of planted or naturally regenerating native tree species
			• Where tree seedlings are planted (e.g., mounded sites):
			  • seedling density of 400 to 1000 stems/ha (combined planted seedlings and/or natural regeneration), dependent on mound density
			  • continuous spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit
			• ≥70% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover)
			Shrub/Graminoid Lowlands:
			• Natural vegetation is regenerating, including at least two characteristic species (vascular and/or nonvascular; e.g., Carex sp. and Sphagnum moss sp.) (classified as per AWCS 2014)
			• No restricted weeds
			• ≥80% cover of native vegetation species in sample plots
				Adaptive management actions for habitat restoration are implemented at sites where the measurable targets have not been met and take into consideration site conditions and other ecological factors that may affect successful restoration.
				Upland Conifer, Deciduous, Mixedwood and Transitional:
				• If seedlings (planted or natural regeneration) are damaged due to access, assess and modify access control measures and plant seedlings to maintain desired seedling density targets
				• If seedlings (planted or natural regeneration) are damaged due to disease, plant seedlings to replace those that have died to maintain desired seedling density targets
				• If seedling growth/vigour (planted or natural regeneration) is impeded by competition from surrounding vegetation, such as grasses, implement spot spraying or manual vegetation control to reduce competition pressure and plant seedlings to maintain desired seedling density targets
				Treed Lowlands:
				• If establishment and growth of planted seedlings is impeded by wet site conditions (e.g., flooding and ingress of invasive species such as cattails), modification of surface drainage patterns may be implemented to facilitate near-surface water flow
				• If natural regeneration of vegetation is impeded, plant alder seedlings to facilitate natural regeneration of shrubs
				• If noxious weed species occur on the Project ROW or on offset locations, implement spot spraying or manual control measures to manage weed populations
				Shrub/Graminoid Lowlands:
				• If natural regeneration is impeded by wet site conditions (e.g., flooding and ingress of invasive species such as cattails), modification of surface drainage patterns) may be implemented to facilitate near-surface water flow
				• If natural regeneration of vegetation is impeded, plant alder seedlings to facilitate natural regeneration of shrubs
				• If noxious weed species occur on the Project ROW or on offset locations. Implement spot spraying or manual control measures, as required to manage weed populations

Note:
1. Abbreviations: Environmental Inspector (EI); equal to or greater than (≥); equal to or less than (≤); hectare (ha); metre (m); right-of-way (ROW); species (sp.).

Table 4-2. Habitat Restoration Evaluation Criteria and Measurable Targets on Non-Operational Lines[1]

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management

Habitat Restoration	• Aerial Monitoring:
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Performance Surveys
		• Total density of planted seedlings and naturally regenerating seedlings (i.e., from seed ingress or suckering)
		• Height and percent cover of seedlings
		• Vigour of seedlings (evidence of chlorosis, pests/disease, browse, other damage)
			Habitat restoration measurable targets are designed to demonstrate restoration success in terms of survival and sustained growth trends of conifer and deciduous trees within five years following completion of restoration.
			Upland Conifer, Deciduous, Mixedwood and Transitional:
			• Seedling density will vary by species with target range from 1600 to 2000 stems/ha (combined planted seedlings and/or natural regeneration) on sites that are not mounded.
			• Seedling density will vary by species with target range from 800 to 1400 stems/ha (combined planted seedlings and/or natural regeneration) on mounded sites (dependent on mound density).
			• Spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit (footprint available for restoration).
			• ≥80% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover).
			Invasive species are not inhibiting the establishment or sustained growth of planted or naturally regenerating native tree species
			Treed Lowlands:
			• Where tree seedlings are planted (e.g., mounded sites):
			• Seedling density of 400 to 1000 stems/ha (combined planted seedlings and/or natural regeneration), dependent on mound density
			• Continuous spatial distribution of seedlings (combined planted seedlings and/or natural regeneration) ≥80% of the restoration unit
			• ≥70% of the tree seedlings (planted and/or natural regeneration) demonstrate sustained growth trends since time of planting (i.e., increasing values for height and percent cover).
			Invasive species are not inhibiting the establishment or sustained growth of planted or naturally regenerating native tree species
				Adaptive management actions for habitat restoration are implemented at sites where the measurable targets have not been met and take into consideration site conditions and other ecological factors that may affect successful restoration.
				• If seedlings (planted or natural regeneration) are damaged due to access, assess and modify access control measures and plant seedlings to maintain desired seedling density targets
				• If seedlings (planted or natural regeneration) are damaged due to disease, plant seedlings to replace those that have died

Note:
1. Abbreviations: Environmental Inspector (EI); equal to or greater than (≥); equal to or less than (≤); hectare (ha); metre (m); right-of-way (ROW); species (sp.).

4.1.2 Access Control/Line-of-Sight

Evaluation criteria and measurable targets used to verify the effectiveness of access control and line-of-sight blocks have been developed in consultation with AEP, Alberta Pacific Forest Industries Inc. (ALPAC) and in accordance with provincial recommendations and guidelines (Pyper and Vinge 2012). Additional consideration is given to whether the restored linear features are on either operational or non-operational lines, and whether the operational lines are parallel to foreign dispositions.

Line-of-sight and access control measures will be monitored where present on non-operational lines (e.g., seismic lines in offset areas) and on operational lines where they are not located parallel to foreign dispositions.

Table 4-3 presents the evaluation criteria, measurable targets, and adaptive management for access control and line-of-sight measures implemented on operational lines. Table 4-4 presents the evaluation criteria, measurable targets, and adaptive management for access control and line-of-sight measures on non-operational lines.

Table 4-3: Access Control/Line-of-Sight Evaluation Criteria and Measurable Targets on Operational Lines[1]

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management

Access Control	• Aerial Monitoring
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Performance Surveys
	• Remote Camera Monitoring
		Evidence and level of vehicular use along the Project ROW and at offset locations will be measured using subjective criteria ratings, as follows:
		• Evidence of access:
		  • Yes/No
		• Evidence of U-turns at access barriers:
		  • Yes/No
		• Access type:
		  • non-motorized
		  • over-snow vehicle
		  • all-terrain vehicle
		  • truck
		  • other (details to be noted)
		• Access level metrics:
		  • absent
		  • low (tracks/trail evident but difficult to discern or appear to be infrequently used)
			Access control targets are designed to prevent access along sections of new alignment of the Project ROW, with the exception of segments paralleling dispositions, and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term:
			• ≤20% increase in access against baseline[2] along sections of new alignment on the Project ROW or at offset locations
			• Success of habitat restoration targets, specifically sustained growth trends, is a good indicator that access is not inhibiting habitat restoration
				Adaptive management actions for access control will enhance or alter current access control measures to improve the effectiveness of these measures for limiting access to areas undergoing restoration.
				• The location, and source and type of access will be investigated, with enhanced access controls added where evidence of access is identified. This will be in the form of physical access barriers such as enhanced use of coarse woody debris, tree felling/tree bending (Cody 2013; Golder 2014), large rocks or fencing.

Line-of-Sight Breaks	• Aerial Monitoring
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Performance Surveys
	• Remote Camera Monitoring
		• Vegetation screens:
		  • spatial distribution (distance between live woody stems)
		  • height of live woody stems
		  • percent cover of live woody stems
			Line-of-sight breaks are designed to block sight lines along sections of new alignment of the Project ROW, with the exception of segments paralleling dispositions, and at offset locations within five years following completion of restoration in caribou range and continuing through the long-term.
			• Line-of-sight is limited to ≤500 m along the linear feature in upland forested areas.
			• Where vegetation screening is used to break the line-of-sight:
			  • seedling densities and growth trends meet the targets for habitat restoration
			  • line-of-sight breaks are in good condition and functional (in terms of blocking line-of-sight)
				Adaptive management actions for line-of-sight breaks will enhance the effectiveness of line-of–sight measures and include:
				• Implementing adaptive management actions associated with habitat restoration to create effective vegetation screens as line-of-sight breaks. For example, adding alder seedlings to a site to enhance rate of shrub growth for establishment of a line of site or use of tree- felling or tree-bending (refer to Cody 2013, Golder 2014), across the ROW where there is suitable thick, adjacent forest cover of either non-merchantable or merchantable coniferous trees.

Note:
1. Abbreviations: Environmental Inspector (EI); equal to or greater than (≥); equal to or less than (≤); hectare (ha); metre (m); right-of-way (ROW); species (sp.).
2. Baseline, for the purpose of this Monitoring Program, means ‘the first monitoring year’ as pre-construction access data is not available.

Table 4-4: Access Control/Line-of-Sight Evaluation Criteria and Measurable Targets on Non-Operational Lines[1]

Objective	Monitoring Method	Evaluation Criteria	Measurable Targets	Adaptive Management

Access Control	• Aerial Monitoring
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Sample Plots
	• Remote Camera Monitoring
		Evidence and level of access will be measured using criteria ratings as follows:
		• Evidence of access:
		  • Yes/No
		• Evidence of U-turns at access barriers:
		  • Yes/No
		• Access type:
		  • non-motorized
		  • all-terrain vehicle
		  • over-snow vehicle
		  • truck
		  • other (details to be noted)
		• Access level metrics:
		  • absent
		  • low (tracks/trail evident but difficult to discern or appear to be infrequently used)
		  • high (tracks/trails appear to be well used; vegetation is trampled down; bare ground might be visible from frequent use)
			Access control targets are designed to prevent access at offset locations that are not contiguous with adjacent linear features within five years following completion of restoration in caribou range and continuing through the long-term:
			• ≤ 20% increase in access against baseline[1] at offset locations that are not contiguous with adjacent linear features
			• Success of habitat restoration targets, specifically sustained growth trends, is a good indicator that access is not inhibiting habitat restoration
				Adaptive management actions for access control will enhance or alter current access control measures to improve the effectiveness of these measures for limiting human use of areas undergoing restoration.
				• The location, and source and type of access will be investigated, with enhanced access controls added where evidence of access is identified. This might be in the form of physical access barriers such as enhanced use of coarse woody debris, tree felling/tree-bending (Cody 2013; Golder 2014).

Line-of-Sight Blocking	• Aerial Monitoring
	  • LiDAR Imagery
	  • 360º Photography
	  • EI Aerial Inspection
	• Ground-Based Monitoring
	  • Establishment Surveys
	  • Sample Plots
	• Remote Camera Monitoring
		• Vegetation screens:
		  • spatial distribution (distance between live woody stems)
		  • height of live woody stems
		  • percent cover of live woody stems
			Line-of-sight breaks are designed to block sight lines along offset locations within five years following completion of restoration in caribou range continuing through the long-term:
			• Line-of-sight is limited to ≤500 m along the linear feature in upland forested areas
			• Where vegetation screening is used to break the line-of-sight: The distribution of remote camera stations will be determined based on the number of access control and line-of-sight breaks
			  • seedling densities and growth trends meet the targets for habitat restoration
			  • line-of-sight breaks are in good condition and functional (in terms of blocking line-of-sight)
				Adaptive management actions for line-of-sight breaks will enhance the effectiveness of line-of-sight measures and include:
				• Implementing adaptive management actions associated with habitat restoration to create effective vegetation screens as line-of-sight breaks. For example, adding alder seedlings to a site to enhance rate of shrub growth for establishment of a line of site or use of tree felling or tree bending (Cody 2013; Golder 2014), across the ROW where there is suitable thick, adjacent forest cover of either non-merchantable or merchantable coniferous trees.

Note:
1. Abbreviations: Environmental Inspector (EI); equal to or greater than (≥); equal to or less than (≤); hectare (ha); metre (m); right-of-way (ROW); species (sp.).
2. Baseline, for the purpose of this Monitoring Program, means ‘the first monitoring year’ as pre-construction access data is not available.

4.2 TIME FRAMES

Monitoring will begin one growing season following the implementation of all habitat restoration and offset measures to allow sufficient time for:

- final clean-up and installation of access control measures where heavy equipment access is required; and,
- a final inspection of habitat restoration and offset measures to verify that the project-specific requirements are satisfied.

To meet the applicable NEB Certificate or Order condition requirements of both short and long-term monitoring for projects:

- short-term monitoring will be conducted at Years 1, 3, and 5 to evaluate habitat restoration establishment, including the need for corrections or adjustments as part of adaptive management (Section 4.0); and
- long-term monitoring will be conducted at Years 10 and 15 (provided that measurable targets have not been met at Year 5) to evaluate habitat restoration performance, including any adaptive management actions applied in the short-term monitoring program and any additional actions that may be required for the long-term monitoring program.

All projects with restoration and offset measures will be monitored in the same years to improve the overall efficiency of the data collection process, including remote camera monitoring. NGTL will continue conducting Post-Construction Monitoring (PCM) along the project footprints, as required under NEB Certificate or Order conditions for each individual project. Where the two programs overlap, monitoring efforts will be coordinated to improve efficiency (e.g., through shared aerial surveys). Although the Monitoring Program and PCM activities will generate separate reports, data collected from both will be used to inform adaptive management actions that may be necessary to enhance habitat restoration performance.

4.3 MONITORING PROGRAM COMPONENTS

The Monitoring Program includes the following components:

- aerial imagery (360º and LiDAR) to be collected in Q3 of Years 3, 5 and 15
- aerial visual surveys (via helicopter) in Q3 and Q4 of Years 1, 3 and 5
- ground-based vegetation surveys in Q3 of Years 1, 3, 5, 10 and 15
- one full calendar year of remote camera photo collection and analysis in Years 1, 3, 5, 10 and 15

Monitoring will be conducted following the protocols developed by NGTL for the purposes of the Monitoring Program and data will be collected by qualified specialists. Consistent sampling protocols ensure the use of repeated measures for each plot and monitoring period. The protocols are based on the most current provincial criteria, standards and restoration guidelines for uplands, transitional forests and lowlands.

Monitoring and reporting will be conducted based on habitat restoration units identified during implementation. The habitat restoration units include:

- natural regeneration;
- treed upland/transitional;
- treed lowlands; and,
- shrub/graminoid lowlands.

To ensure consistency in timing and frequency of monitoring of habitat restoration and offset measures, monitoring will be conducted during Q3 of each monitoring year. Monitoring in Q3 of each monitoring year will:

- avoid working in the restricted activity period (RAP) for caribou – February 15 to July 15;
- reduce monitoring activities in caribou range as a whole; and,
- sample habitat restoration measures during the growing period.

Monitoring results, as well as any necessary adaptive management actions, will be reported to the NEB, ECCC and AEP according to project approvals and conditions (Section 5).

Access control and line-of-sight blocking measures will be monitored on operational and non-operational lines using aerial and ground-based sampling protocols, and through the deployment of remote, motion-triggered cameras.

4.4 AERIAL MONITORING

High-resolution light detection and ranging (LiDAR) imagery will be collected to evaluate revegetation success in restoration areas. LiDAR is an accepted assessment tool for measuring tree growth and is used as common practice by the forestry industry. LiDAR allows for a large volume and high resolution of detailed biophysical data to be collected in a short period of time, without the surface disturbance of ground-based monitoring. It also allows for improved statistical analysis of restoration performance and measurable targets.

In addition to LiDAR, 360° geo-referenced aerial photography will be reviewed to evaluate revegetation processes in the restoration areas. Aerial photography review is an effective method for conducting spatial and temporal assessment of restoration performance. The 360° aerial photography provides a full visual documentation for all restoration areas and a means to verify areas that require corrective action.

Access control and line-of-sight breaks will be monitored on operational and non-operational lines that are not parallel to foreign dispositions. NGTL's Environmental Inspectors (EI) will conduct aerial (via helicopter) inspections specifically assessing access control and line-of-sight measures.

4.4.1 LiDAR Imagery

LiDAR imagery has become an increasingly popular tool for forestry and environmental assessment programs as the technology has evolved (Erdody and Moskal 2009). The benefits of collecting LiDAR data for this monitoring program include:

- increasing the number of sample plots (i.e., replication) used to test for statistical differences between restoration performance and measurable targets for each restoration unit;
- overlaying LiDAR-derived sample plots with ground-based sample plots to verify measure performance data collected from both monitoring programs;
- deriving additional biophysical parameters to account for the localized natural variability associated with each sample plot to improve the precision of statistical inferences of the measurable targets; and,
- achieving short-duration monitoring process with less disturbance to vegetation and wildlife.

LiDAR imagery will allow remotely interpreted habitat restoration metrics to be correlated against their respective targets to verify restoration performance for each restoration unit across each monitoring year. In this regard, the objectives of aerial monitoring are to:

- assess the restoration performance and test for statistical differences against the measurable targets (e.g., vegetation height, percent ground cover, stem density);
- account for natural variability associated with localized parameters that might affect restoration performance (i.e., slope, aspect, ground roughness, site severity index, solar radiation index);
- assess the condition and ongoing effectiveness of line-of-sight breaks in the form of vegetation screens implemented at strategic locations (i.e., vegetation height); and,

- identify specific areas that might require adjustment as part of adaptive management.

LiDAR will be implemented at Year 3 as an aerial monitoring method, assuming sufficient growth trajectory is achieved to differentiate seedlings from surrounding vegetation and terrain.

4.4.2 Sampling Frequency

Aerial surveys collecting LiDAR imagery and 360° aerial photography will be conducted in Q3 of the Years 3, 5 and 15, outside the restricted activity period for caribou. High-frequency LiDAR sampling will be conducted at an elevation of approximately 300 m to effectively cover the width of the Project footprint and linear features where offset measures are applied (i.e., 250 m swath width). LiDAR-derived sample plots will be identical in size to ground-based sample plots. Sample plots will be systematically stratified in each restoration unit at a sampling intensity rate of 10 plots/km.

High-resolution 360° aerial photography will be collected at both high and low elevations. High-elevation photography will provide a general overview of the habitat restoration and offset measure locations, including surrounding land use. Low-elevation photography will be used to verify habitat restoration performance and validate LiDAR data. Geo-referenced imagery will be collected at approximately 50 m intervals along linear features where habitat restoration and offset measures are applied.

4.4.3 Data Analysis

From the raw LiDAR point cloud data, a bare earth (BB) digital elevation model (DEM), as well as a full feature (FF) DEM will be generated. The BB DEM is a representation of the earth's surface in the absence of biophysical features. The FF DEM contains all biophysical features captured by the LiDAR system. The DEMs are generated using industry-standard interpolation methods available in GIS. LiDAR data will be stored in geo-referenced ASCII/LAS file formats, along with restoration performance data and other parameters generated for each sample plot. Restoration performance data are tied to the evaluation criteria and measurable targets and will be derived as follows:

- Vegetation Height (m): A canopy height model will be generated from the aerial dataset. The raster calculation allows the bare earth model to be subtracted from the FF DEM to result in average vegetation height for each sample plot;
- Stem Density (stem/ha): Allometric equations used for estimating stem density are processed in the raster calculation that allows the FF model to estimate stem density for each sample plot;

- Ground Cover (%): A ground cover model will be generated from the aerial dataset. The raster calculation allows the FF model to ground cover for each sample plot; and,
- Sight-Line Model (m): A sight-line model will be generated from the aerial dataset. The raster calculation allows the FF model to estimate sight-line distance at a height of 1.5 m at each sample plot in upland restoration units.

Additional parameters that will be calculated to assess variability of site conditions that could affect restoration performance include:

- Ground Roughness (m^2): The BB DEM is used in combination with grid statistics tools that allow the calculation of standard deviation of elevation change in each sample plot;
- Slope (%): The BB DEM is used in combination with grid statistics tools that allow the calculation of standard deviation of elevation change in each sample plot;
- Aspect (°): The BB DEM is used in combination with grid statistics tools that allow the calculation of standard deviation of elevation change in each sample plot;
- Solar Radiation Index (SRI): Slope and aspect rasters, in addition to a latitude raster, are used to calculate SRI (Keating et al. 2007). The latitude raster is created by generating a point shapefile in each sample plot. SRI provides a means to correlate habitat restoration performance with slope and aspect on a single scale, considering daylight hours, and is represented by the following equation:

  $$SRI = [\cos(latitude) \times \cos(slope)] + [\sin(slope) \times \cos(aspect)]$$

- Site Severity Index (SSI): Slope and aspect rasters are used to calculate SSI by generating a point shapefile in each sample plot (Nielsen and Haney 1998; Boyce et al. 2003). SSI provides a means to correlate habitat restoration performance with slope and aspect on a single scale and is represented by the following equation:

  $$SSI = [\sin(aspect + 225) \times (slope / 45)]$$

4.5 GROUND-BASED MONITORING

Ground-based monitoring will provide detailed information on species composition and ecological conditions to confirm that restoration targets are on a trajectory toward establishment of natural ecosystem types.

The objectives of ground-based monitoring are to:

- collect data to evaluate restoration performance with respect to the measurable targets (e.g., seedling survival, vegetation height, percent ground cover and species composition);

- verify restoration performance data obtained from LiDAR data in each restoration unit where ground-based sample plots are located (for monitoring years where LiDAR is collected);
- evaluate the condition of access control measures and collect data used to verify their effectiveness; and,
- document incidental observations (e.g., wildlife, wildlife tracks, evidence of wildlife browsing and general observations concerning measure effectiveness).

Ground-based monitoring will allow a reclamation specialist to verify the measure's effectiveness and recommend corrective actions if required.

4.5.1 Plot Selection

Ground-based monitoring will be conducted at randomly-selected sample plots within each restoration unit. Preliminary ground-based sample plot locations will be randomly-selected and reviewed on the alignment sheets and habitat classification maps in Q2 of the year following implementation. Final sample plot locations will be verified and surveyed during first-year ground-based monitoring in Q3 of the same year.

An appropriate number of sample plots will be selected, representing planted restoration treatment habitat units, with at least 13 plots located in each planted habitat unit (i.e., treed upland and treed lowland), shrub/graminoid lowlands and in naturally regenerating areas. Since shrub/graminoid lowlands do not have a significant treed component, natural regeneration is the primary restoration measure, except where trees have been planted as a line-of-sight break.

The distribution of natural regeneration plots will be proportional to the area of treed upland and treed lowland that exist within the Project area. For example, if the Project is 80% treed upland and 20% treed lowland, natural regeneration plots would be distributed such that 10 plots are in treed upland and 3 plots are in treed lowland habitat units.

4.5.2 Sampling Protocol

Establishment of ground-based sample plots will follow standard criteria for regeneration assessment and reclamation practices (AESRD 2013; ASRD 2000). For plots established where habitat restoration and offset measures are implemented on operational lines, one 3.99 m radius circular plot (50 m^2) will be established. For plots established where measures are implemented on non-operational lines (i.e., seismic lines), the plot size will be reduced to a 1.79 m radius circular plot (10 m^2). All sample plot locations will be recorded using GPS and appropriately identified to aid in locating the plots in subsequent monitoring years.

The distribution of plots in each restoration unit will be determined based on the availability of sites and will be detailed in the Year 1 monitoring report. The use of a repeated measures experiment design will improve the precision of estimates used to verify restoration performance through the duration of the aerial and ground-based monitoring program (see Section 4.4 and 4.5).

Ground-based monitoring will be conducted outside the caribou RAP in Q3 of Year 1 (first year – baseline), 3, and 5, and at the Year 10 and Year 15 milestones if restoration targets have not been met after Year 5 (assuming plots remain accessible after Year 5; see Section 5.0).

4.5.3 Data Collection

Each monitoring year, a qualified specialist will record restoration performance data for each ground-based plot, including:

- vegetation height, density and vigour of seedlings planted or naturally regenerating (tally of species by height class);
- vegetation community composition data, including vegetation strata height, species and percent cover information (e.g., trees, shrubs, forbs, grasses, nonvascular plants and non-native, invasive or weed species);
- evidence of access (e.g., access type and level) and, where access-control measures are implemented, verification of their ongoing functionality as a sufficient barrier or deterrent;
- line-of-sight measurements using Robel poles for vegetation screens;
- incidental wildlife sign (tracks, scat, browsing); and,
- soil information (e.g., percent surface substrate to determine percent vegetated vs. non-vegetated, slope and aspect, drainage, moisture and nutrient regime, surface organic matter thickness).

Photographs of each sample plot will be taken and ground vegetation will be reviewed in conjunction with geo-referenced 360° aerial photography and aerial inspection reports to provide a visual reference for each site, each monitoring year. There is potential for introduction of error and/or limitations to correctly validating aerial-based survey (i.e., difficulty in correctly identifying tracks and wildlife sign from the altitude of a helicopter), however, limitations and uncertainties will be discussed in the Monitoring Program reports that will be filed with the NEB as per the scheduled identified in Section 6.

4.5.4 Experimental Design

A one-way repeated measures experimental design will be used to evaluate restoration performance for each individual habitat restoration unit separately because

of the inherent differences associated with their biophysical characteristics (i.e., treed upland/transitional vs. treed lowlands vs. shrub/graminoid lowlands). Repeated measure designs are generally preferred over other factorial designs (where they can be implemented) as they improve the precision of estimates derived on the response variable (Montgomery 2001; Kuehl 2000).

Measurements of restoration performance collected as part of the ground-based monitoring program will be repeated at each sample plot location each monitoring year. Measurements of restoration performance collected as part of the aerial monitoring program, will include LiDAR and high-resolution 360° aerial photography completed in Q4 at Year 5 and Year 15. Aerial inspections to review habitat restoration, access control and line-of-sight measures in consideration of their respective evaluation criteria and measurable targets will be conducted in Q3 and Q4 of each monitoring year. Within each habitat restoration unit, sample plots will also be established at control locations where no restoration measures are applied to evaluate natural regeneration. Control locations will be randomly selected in natural regeneration areas within treed habitat restoration units along operational and non-operational locations. 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 measurable target, μ is the overall mean, α_i is the effect of each monitoring year, τ_j is the effect of each sample 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 monitoring each sample plot, each monitoring year. The degree to which restoration measures achieve their respective targets will be determined by a positive (greater than zero) regression coefficient for the parameter “year”, where the first monitoring year will act as a baseline.

Additional biophysical parameters derived from LiDAR (see Section 4.4), although not of primary interest, will be included as covariates to account for natural variability associated with each sample plot where they are observed to have a statistically significant effect on the measurable target response. Measurable targets will be modelled according to their respective distribution. Where data are identified to be non-normally distributed, other distribution functions consistent with the structure of the raw data will be used to test statistical hypotheses (Cameron and Trivedi 2007; Zuur et. al. 2007).

4.5.5 Power Analysis

A power analysis was conducted for the ground-based monitoring program to determine the required number of sample plots necessary to effectively identify

statistical differences for measurable target responses between each monitoring year (i.e., increasing values for vegetation height and ground cover, and sustained planted stem density). The power analysis was conducted using software developed by Faul et al. (2009), which has applications specific to repeated measure designs. The power analysis assumes five repeated measurements, representing each monitoring year, taken on each sample plot, an alpha (α) of 0.05 (i.e., level of significance for hypothesis tests) and an effect size of 0.4 (recommended by Faul et al. [2009] for one-way repeated measure designs).

Results of the power analysis indicate that for each restoration unit a minimum of 13 sample plots will provide sufficient statistical power ($1 - \beta = 0.95$) to detect statistical differences for measurable target responses between each monitoring year (see Figure 4-1). Although there is no absolute method for determining the most appropriate sample size for a study, a general rule for data to conform to a normal distribution coincides with statistical power greater than 0.8 (Montgomery 2001). Thus, for the ground-based monitoring program, a minimum of 52 sample plots (13 plots x 4 units) will be monitored each monitoring year for each restoration unit, including natural regeneration areas.

A power analysis for the aerial monitoring program was not conducted as the sampling rate of 10 sample plots/km exceeds the power requirement necessary for the aerial monitoring program.

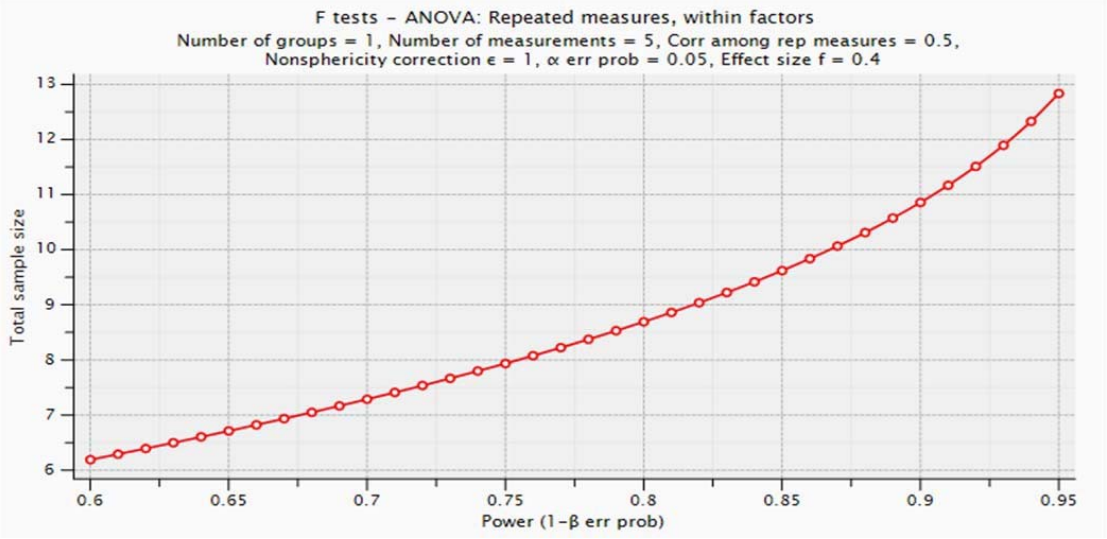

Figure 4-1: Power Analysis Results for the Ground-Based Monitoring Program

4.5.6 Variance Partitioning

For variance partitioning, the minimum number of sample plots (n=13) for the ground-based monitoring program for each restoration unit and natural regeneration area are presented in Table 4-2. Degrees of freedom for within effects are included to

demonstrate how the source of error is derived, they are not considered an independent effect for modelling purposes. Aerial monitoring will use the same variance structure, with the benefit of increased degrees of freedom for sample plot effects and the overall variance structure due to a higher rate of sampling in each restoration unit.

Table 4-5: Variance Partitioning for the Ground-Based Monitoring Program

Effect	Degrees of Freedom (*df*)
Between Effects (Years)	4 - (5 Years – 1)
Within Effects (Plots in Monitoring Years)	*60 - (Total Sample Plots Monitored – 5 Monitoring Years)*
Sample Plot Effect	12 - (Minimum 13 Sample Plots Monitored – 1)
Error	48 - (Within Effects – Sample Plot Effect)
Total	64 - (Total Sample Plots Monitored – 1)

4.5.7 Data Verification

Data collected for aerial and ground-based sample plots will be verified and, where necessary, calibrated to ensure sampling error and bias are accounted for in the final data set. Differences between each measurable target for aerial and ground-based sample plots will be analyzed using paired t-tests or an equivalent test for paired data. As the Monitoring Program progresses, the model effect of "year" (i.e., monitoring year) will be included in the analysis to test measurable target response between each monitoring year. The estimate of average measurable target response (per ha) will be used to evaluate LiDAR-derived sample plots and verify habitat restoration performance.

4.6 REMOTE CAMERA MONITORING

NGTL will implement remote camera monitoring after completion of habitat restoration activities and offset measures to verify the effectiveness of access control on the ROW during pipeline operations. The target of the Monitoring Program is to decrease access by 20% at access control locations along the ROW within five years following the completion of restoration activities.

NGTL proposes to report incidental wildlife occurrence via remote camera on operational and non-operational lines where access control and line-of-sight measures are implemented and there are no parallel dispositions (see Section 2). However, wildlife response to the measures is not included in the design of the Monitoring Program. Wildlife population research currently being conducted by the province, academia and industry associations provides a more informative and scientifically robust foundation to improve decision making for habitat restoration. NGTL will continue to work with the province and industry associations to ensure that measures are implemented that scientifically demonstrate benefit for caribou and caribou habitat.

Remote cameras provide a non-invasive monitoring method that consists of a digital camera, external flash and infrared motion sensor. Remote cameras take a time stamped digital photograph of the subject that triggers the sensor, thus providing a permanent record of occurrence at a site (O'Connell et al. 2010). Remote cameras increase the degree of monitoring intensity over a continuous timeframe, which may verify the effectiveness of access control.

Inherent challenges associated with the use of remote cameras include their operational limitations during winter months, particularly prolonged cold weather events where regular maintenance is required, and the possibility of theft (O'Connell et al. 2010).

Cameras will be deployed in Q3 of each applicable monitoring year (Section 4.3) and will collect data for one full calendar year. This methodology will provide a greater representation of seasonality to the camera monitoring program as a whole, and access in non-frozen conditions will minimize the potential to attract humans and wildlife to access control and line-of-sight locations (e.g., packing down snow could attract people or predators to monitoring locations).

If data are insufficient to verify the effectiveness of access control then adjustments to the monitoring design will be made. If access is evident, then an assessment of the effectiveness will be completed to provide recommendations for adjusting access control.

4.6.1 Desktop Review and Preliminary Site Selection

A desktop assessment of access control locations will be conducted using digital imagery. The camera locations will be chosen based on the following criteria:

- within a designated caribou range boundary
- located on a section of new alignment (not parallel to other dispositions) created by the proposed or constructed project ROW
- near an active intersection with the proposed or constructed project ROW and another linear feature (i.e., roads, pipelines, transmission lines)
- within a treed area with trees of adequate size to mount a camera on

Once the proposed sites are selected, the locations will be mapped by field personnel to guide the deployment of cameras in the field. There is an element of flexibility in site selection to allow for optimum camera placement in consideration of adjacent vegetation type and structure.

4.6.2 Equipment

Reconyx cameras will be labelled with unique identifier numbers and site names and placed adjacent to access control measures. A tablet/laptop will be used for

documenting site information, navigation, and photographic data collection. SD memory cards will be installed and the cameras will be pre-set to desired settings using the Reconyx software provided with camera. Cameras will be tested for three days prior to use in the field to ensure they are functioning.

4.6.3 Camera Deployment

The pre-selected camera sites will be assessed in the field and cameras will be deployed between 0 and 50 m of the pre-selected site and between 20 and 75 m from the access control measure. Suitable trees must be available for camera mounting and This flexibility in distance is required to find suitable trees for mounting the cameras and to allow topographical restrictions (e.g., slope direction). Sites will be revised or removed if safety in an issue (e.g., bear encounter or frequent bear signs, hazardous road conditions, helicopter access issues) and the next pre-selected site will be field evaluated. A walk-test will be conducted to ensure that the cameras capture the point of interest.

4.6.4 Camera Checks and Maintenance

If weather allows for helicopter access, crews will revisit camera locations in Q4 of each monitoring year to exchange the camera SD memory cards and change the batteries to AA lithium batteries, in preparation for the winter season. Cameras will be replaced if damaged or vandalized. Grasses and shrubs will be cleared from in front of the cameras to minimize the number of photographs triggered by vegetation.

4.6.5 Data Collection

Camera data collection will include:

- unique identifier number and site name
- SD memory card unique identifier number and name
- camera case unique identifier number and name
- date and time of camera deployment
- crew name(s)
- UTM (NAD 83)
- battery type
- battery life
- ecosite/wetland type
- description of the camera location (e.g., pipeline ROW, seismic line)
- description of access control treatment type, if applicable (e.g., coarse woody debris, mounding)

- linear feature width (estimate)
- binary variable indicating evidence of human access (yes/no)
- human access type (i.e., ATV, truck, heavy equipment, N/A)
- binary variable indicating evidence of wildlife access (yes/no)
- classification of human access level (low: track/trail evident but difficult to discern or appears to be infrequently used; or high: tracks/trail well used, vegetation trampled, bare ground may be visible [NGTL 2015])
- classification of wildlife access level (low/high, as defined above)
- photographs of the camera placement on the tree, and photograph facing right from the camera location along the ROW, and a photograph facing left from the camera location along ROW

4.6.6 Data Management

Remote camera data will be downloaded and backed up onto portable hard drives. Data field sheets will be checked by the crews each evening, scanned, and sent to the project manager each evening to be quality checked.

The primary focus of the camera monitoring program is to evaluate the effectiveness of access control measures. Photographs will be categorized using the access control and line-of-sight evaluation criteria to provide count-based metrics (Tables 4-3 and 4-4). The unit of measurement used to detect a change in access is a "daily human access rate" (i.e., within a 24-hour period).

Photographs of wildlife will be evaluated at individual species level and at pooled species categories to provide count-based metrics. Pooled categories include:

- all prey species (deer, moose, elk and caribou) including juveniles pooled into a total prey category;
- all predators (wolf, grizzly bear, black bear, cougar, lynx and coyote) pooled into a total predator category;
- moose and caribou calves pooled with adult moose and caribou; and,
- deer species (whitetail and mule deer) as a pooled group.

5.0 ADAPTIVE MANAGEMENT AND CONTINUOUS IMPROVEMENT

5.1 ADAPTIVE MANAGEMENT

Monitoring and adaptive management are important elements to inform whether restoration investments are contributing meaningfully to the strategic outcome of conservation and recovery of woodland caribou.

Adaptive management procedures for the monitoring program were developed following guidance provided by the Operational Policy Statement for Follow-Up Programs under CEAA (CEA Agency 2011). The goal of adaptive management, within the context of this Monitoring Program, is to provide a systematic approach for evaluating program outcomes and addressing unsuccessful restoration measures by adjusting or supplementing how these measures are implemented. Adaptive management requires an assessment of the underlying cause(s) that might have led to unsuccessful restoration, including site conditions and other factors that might be affecting recovery.

Adaptive management is the systematic process of monitoring and assessing outcomes and modifying habitat restoration measures, if necessary. Adaptive management is intended to:

- evaluate restoration measures, performance and effectiveness
- identify the cause of any underperforming measures (i.e., microsite conditions that are either not conducive or suitable for establishment of target vegetation)
- address underperforming measures requiring supplemental or corrective action

The habitat restoration measures are considered successful when monitoring results indicate measurable targets have been reached. No additional monitoring will be considered necessary at that point. If, prior to reaching the targets, results indicate that restoration and offset measures are not on trajectory to success, corrective action will be taken and monitoring will continue until a positive trajectory is achieved. The extent of additional monitoring required for adaptive management actions will be site-specific.

5.2 CONTINUOUS IMPROVEMENT

Continuous improvement through adaptive management will be an integral part of the Monitoring Program. Modifications may include, but not be limited to:

- integrating knowledge gained through industry-driven research and other funded research into current and future caribou habitat restoration and monitoring programs
- integrating consultation with Aboriginal communities

- optimizing field logistics and data turnover processes
- integrating guidance and policy from provincial authorities

As outlined below, the Monitoring Program will continue to evolve as more information becomes available and learnings are incorporated.

5.2.1 Research Initiatives

Caribou research is a growing field and it is anticipated that methods to restore habitat will continue to be tested and refined. NGTL will continue to incorporate new information on caribou mitigation and habitat restoration planning and implementation. If new research identifies success with alternative methods of caribou habitat restoration, NGTL will determine if the methods are applicable for use on pipeline ROWs. Where appropriate, applicable, and supported by the regulatory authorities, these restoration measures will be incorporated in the toolbox of measures available to NGTL to restore caribou habitat. The implementation of any new restoration measures will be monitored to evaluate success and efficiency.

Some key initiatives have identified important lessons learned related to oil and gas development in caribou range. Many projects are focussed 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 (e.g., CRRP 2007a, 2007b; 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 (COSIA 2015; CRRP 2007a, b; Enbridge 2010; Golder 2010, 2011). Large-scale habitat restoration projects near Grande Prairie, Cold Lake, and Fort McMurray, Alberta, as well as NGTL's projects in caribou habitat have contributed learnings to these initiatives.

5.2.2 Provincial Authority Guidance

The first draft of Alberta's Provincial Woodland Caribou Range Plan was released on December 19, 2017, with a final plan anticipated for release in Q2 2018. Once finalized, this document will guide the implementation of measures to address threats to caribou, including the approach to monitoring and reporting, to achieve population and distribution objectives (Government of Alberta 2017). Once the Provincial Woodland Caribou Range Plan becomes comes into effect, and in consideration of ongoing industrial research, NGTL will continue to refine its habitat restoration and monitoring programs to align with Provincial objectives.

In addition, NGTL continues to consult with the Province on a project specific basis to determine the location of habitat restoration and offset measures. AEP has directed NGTL to implement offsets on existing unrestored ROWs in caribou range to assist in reducing the industrial footprint in caribou range.

5.2.3 Removing Measures

Methods that prove to be ineffective will be removed from the decision frameworks and the Monitoring Program. Examples of these measures include earth and wood berms, and access control/line-of-sight measures on parallel foreign dispositions.

5.2.4 Third Parties

To avoid the disturbance of habitat restoration measures from third parties NGTL has implemented changes to the terms and conditions for new crossing agreements specifying that avoidance of NGTL's habitat restoration and offset measures is preferred. If disturbance does occur, the third party is responsible for restoring the ROW to pre-disturbance conditions, to the extent practical. The third party will be required to comply with all reasonable instructions of an NGTL Representative to complete the work.

5.2.5 Industry Collaboration

Within the Canada's Oil Sands Innovation Alliance (COSIA) land focus area is a caribou habitat restoration initiative, which aims to improve woodland caribou habitat quality and herd survival through restoration of legacy seismic lines.

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. NGTL has implemented mounding as a restoration measure on operating lines.
- 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, which consists of 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 of approximately 570 km^2.
- The LiDea Project, which 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 and monitor 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. Likewise, research conducted by RICC will provide information on the effectiveness of measures implemented to reduce predator and primary prey use of linear features.

Although currently not an active member of RICC, NGTL has collaborated with its members on restoration projects. 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.

NGTL is also a supporter of some significant research initiatives on boreal caribou through the Research and Effectiveness Monitoring Board (REMB) in British Columbia (BC). The program is multifaceted but includes the restoration and monitoring of caribou habitat in BC, research into predator/prey relationships, other research on boreal caribou in relation to their habitat, such as wildlife responses to habitat restoration in the Parker Range in BC.

6.0 SCHEDULE FOR MONITORING AND REPORTING

NGTL intends to conduct monitoring across a 15 year timeframe beginning in Q4 of 2019 to allow for one complete year of remote camera monitoring. Results, trends, and adjustments to monitoring methodology, frequency, or timing will be evaluated after each monitoring year. Monitoring results, as well as any necessary adaptive management actions, will be reported to the NEB, ECCC, and AEP as per the schedule outlined in Table 6-1.

Table 6-1: Monitoring and Reporting Schedule

Activity	2017				2018 (Year 1)				2019				2020 (Year 3)				2021				2022 (Year 5)				2023				2027 (Year 10)				2028				2032 (Year 15)				2033			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Final Clean-Up Activities and Access Control	■																																										
Implement and Inspect Final CHRP and OMP Measures (Liege Lateral Loop 2 – Thornbury Section and Dillon River Wildland park)			■	■																																						
Aerial Monitoring (Access Control/Line-of-Sight EI Inspection)							■	■							■	■							■	■							■	■							■	■				
Remote Camera Monitoring (Deployment and Retrieval)							■	■	■	■					■	■	■	■					■	■	■	■					■	■	■	■					■	■	■	■	■	■
Aerial Monitoring (LiDAR/360° Photography)																■								■																				
Ground-Based Monitoring (Habitat Restoration/Access Control/Line-of-Sight)							■								■								■								■								■					
Adaptive Management (Habitat Restoration/Access Control/Line-of-Sight)																							■	■							■	■							■	■				
Monitoring Reports (NEB, ECCC and AEP)												■								■								■								■								■

7.0 REFERENCES

AENV (Alberta Environment). 2001. Reclamation Assessment Criteria for Pipelines – 2001 Draft. 76 pp + appendices. Website: http://environment.gov.ab.ca/info/library/6883.pdf. Accessed July 2013.

AENV. 2008. Guideline for wetland establishment on reclaimed oil sands leases (2nd edition). Prepared by Harris, M.L. of Lorax Environmental for the Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association, Fort McMurray, Alberta. December 2007.

AENV. 2011. 2010 Reclamation Criteria for Wellsites and Associated Facilities for Forested Lands. Updated June 2011. Alberta Environment, Edmonton, Alberta. 99 pp.

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

ASRD (Alberta Sustainable Resource Development). 2000. Alberta Regeneration Survey Manual: Field Edition. Effective May 1, 2000. Forest Management Branch. Edmonton, AB.

Boyce, M.S., J.S. Mao, E.H. Merrill, D. Fortin, M.G. Turner, J. Fryxell and P. Turchin. 2003. Scale and heterogeneity in habitat selection by elk in Yellowstone National Park. EcoScience 10(4): 421–431.

Cameron, A.C and P.K. Trivedi. 2007. Regression Analysis of Count Data. (6th ed.). New York, N Y. Cambridge University Press.

CEA Agency (Canadian Environmental Assessment) Agency. 2011. Operational Policy Statement on Adaptive Measures under the Canadian Environmental Assessment Act. Website: http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=50139251-1.

Cody, M. 2013. Restoration Efforts in Northern Alberta: Knowledge Sharing. Cenovus Linear Deactivation (LiDEA) Projects Update. Golder Restoration Update Workshop. June 6, 2013.

COSIA (Canada's Oil Sands Innovation Alliance). 2015. COSIA: Canada's Oil Sands Innovation Alliance. Website: https://www.cosia.ca/. Accessed: September 2015.

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

CRRP (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.

DeMars, C. and S. Boutin. 2014. Assessing spatial factors affecting predation risk to boreal caribou calves. Final Report. Science and Community Environmental Knowledge. 145 pp.

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

Erdody, T.L. and L.M. Moskal. 2009. Fusion of LiDAR and Imagery for Estimating Canopy Fuel Metrics in Eastern Washington Forests. American Society for Photogrammerty and Remote Sensing 2009 Annual Conference. Baltimore, MD. March 2009.

Faul, F., E. Erdfelder, A. Buchner and A.G. Lang. 2009. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. Behavior Research Methods 41: 1149–1160.

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 (Golder Associates Ltd.. 2014. Linear Deactivation Guidance Document. Submitted to: Canadian Natural (Kirby), Devon Canada Corporation and MEG Energy Corp.

Government of Alberta. 2013. Alberta Wetland Policy. Website: http://www.waterforlife.alberta.ca/documents/Alberta_Wetland_Policy.pdf

Government of Alberta. 2017. DRAFT Provincial Woodland Caribou Range Plan. Website: http://aep.alberta.ca/fish-wildlife/wildlife-management/caribou-range-planning/documents/DRAFT-CaribouRangePlanAndAppendices-Dec2017.pdf

Halsey, L.A., D.H. Vitt, D. Beilman, S. Crow, S. Mehelcic and R. Wells. 2004. Alberta Wetlands Inventory Classification System, Version 2. Alberta Sustainable Resource Development, Resource Data Branch. Edmonton, AB. 54 pp. Website: http://environment.gov.ab/info/library/8342.pdf.

Keating, K.A., P.J.P. Gogan, J.M. Vore and L.R. Irby. 2007. A simple solar radiation index for wildlife habitat studies. Journal of Wildlife Management 71(4): 1344–1348.

Kuehl, R.O. 2000. Design of Experiments: Statistical Principles of Research Design and Analysis. (2nd ed.). Brooks/Cole. Pacific Grove, CA.

Montgomery, D.C. 2001. Design and Analysis of Experiments. (5th ed.). John Wiley and Sons Inc. New York, NY.

Nielsen, S.E. and A. Haney. 1998. Gradient responses for understorey species in a bracken grassland and northern dry forest ecosystem on northeast Wisconsin. Transactions of the Wisconsin Academy of Sciences, Arts and Letters 86: 149–166.

O'Connell, A. F., Nichols, J. D., & Karanth, K. U. 2010. Camera traps in animal ecology: methods and analyses. Springer.

Osko and Glasgow. 2010. Removing the Well-Site Footprint: Recommended Practices for Construction and Reclamation of Well-sites on Upland Forests in Boreal Alberta. Department of Biological Sciences, University of Alberta.

Pyper, M. and T. Vinge, 2012. A visual guide to handling woody materials for forested land reclamation. Oil Sands Research and Information Network, University of Alberta, School of Energy and the Environment, Edmonton, Alberta Report No. TR-31. 10 pp

Tigner, J., Bayne, E. M. and Boutin, S. 2014, Black bear use of seismic lines in Northern Canada. The Journal of Wildlife Management, 78: 282–292.

Zuur, A.F., Leon, E.N. and G.M. Smith. 2007. Analyzing Ecological Data. Springer Science. New York, NY.